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U.S. ENVIRONMENTAL PROTECTION AGENCY

Office of Radiation Programs

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr'a
10^{9}	giga	jī'ga
10^{6}	mega	mĕg'a
10^{3}	kilo	kĭ'lo
10^{2}	hecto	hĕk'to
10	deka	dĕk'a
10^{-1}	deci	dĕs'i
10^{-2}	centi	sĕn'ti
10^{-3}	milli	mĭl'i
10^{-6}	micro	mī'kro
10^{-9}	nano	năn'o
10^{-12}	pico	pē'ko
10^{-15}	femto	fĕm'to
10^{-18}	atto	ăt'to

SYMBOLS, UNITS, AND EQUIVALENTS

Symbol	Unit	Equivalent
Å	angstrom	10^{-10} meter
A	ampere(s)	
a	annum, year	
BeV	billion electron volts	GeV
Ci	curie	3.7×10^{10} dps-2.22×10^{12} dpm
cpm	counts per minute	
dpm	disintegrations per minute	
dps	disintegrations per second	
eV	electron volt	1.6×10^{-12} ergs
g	gram(s)	3.527×10^{-2} ounces = 2.205×10^{-3} pounds
Hz	hertz	cycle per second
kVp	kilovolt peak	
m	meter(s)	39.4 inches
m^3	cubic meter(s)	
mCi/mi^2	millicuries per square mile	0.386 nCi/m^2 (mCi/km^2)
mg	milligram(s)	
mi	mile(s)	
ml	milliliter(s)	
nCi/m^2	nanocuries per square meter	2.59 mCi/mi^2
R	roentgen	
rad	unit of absorbed radiation dose	100 ergs/g
s	second	

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RADIATION DATA AND REPORTS

Volume 14, Number 5, May 1973

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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CONTENTS

Page

REPORTS

Tritium Burdens in Two Arctic Villages ---- 273
John A. Eckert and Roy B. Evans

DATA

SECTION I. MILK AND FOOD ---- 277

Milk Surveillance, January 1973 ---- 277

Milk Surveillance Programs, November 1972
NERC-LV ---- 286

Food and Diet Surveillance ---- 288

SECTION II. WATER ---- 289

Water Surveillance Programs, November, 1972,
NERC-LV ---- 290

Tritium Surveillance System, October-December 1972 ---- 294

CONTENTS—continued

Page

SECTION III. AIR AND DEPOSITION ---- 298

Radioactivity in Airborne Particulates and Precipitation-- 298

1. Radiation Alert Network, January 1973 ---- 299

2. Canadian Air and Precipitation Monitoring Program, January 1973 ---- 301

3. Pan American Air Sampling Program, January 1973, *PAHO and EPA* ---- 302

4. California Air Sampling Program, January 1973 ---- 302

Air Surveillance Network, January 1973, *NERC-LV* ---- 305

Surface Air Sampling Program—80th Meridian Network, January-December 1970, *HASL* ---- 307

SECTION IV. OTHER DATA ---- 313

Offsite Surveillance Around the Nevada Test Site, January-June 1970, *NERC-LV* ---- 313

Environmental Levels of Radioactivity at Atomic Energy Commission Installations ---- 316

1. Argonne National Laboratory, January-December 1971 ---- 317

Reported Nuclear Detonations, April 1973 ---- 331

Synopses ---- iii

Guide for Authors ---- Inside back cover

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Robert W. Fri, Acting Administrator

Reports

Tritium Burdens in Two Arctic Villages

John A. Eckert and Roy B. Evans [1]

During a routine visit to measure cesium-137 burdens in residents of two Alaskan villages, drinking water and urine samples were collected and subsequently analyzed for tritium by the National Environmental Research Center-Las Vegas. The mean concentrations at Noatak, Alaska, were 1,200 pCi/liter and 1,500 pCi/liter for tritium in drinking water and urine, respectively. At Kiana, the mean tritium concentration in drinking water was <400 pCi/liter, and the mean tritium concentration in urine was 1,000 pCi/liter.

The National Environmental Research Center, Las Vegas, Nev., has conducted a surveillance program to measure cesium-137 burdens in Alaskan natives since 1968 (*1*). During a routine visit to measure cesium-137 burdens in village residents, urine samples were collected and subsequently analyzed for tritium concentrations. Single urine samples were collected from nine residents of Noatak, Alaska, and 10 residents of Kiana, Alaska, on May 10, 1972 and May 9, 1972, respectively. Figure 1 shows the location of the two Arctic villages. A drinking water sample also was collected in each village.

Sample collection

Urine samples were collected only from residents not wearing luminous dial wrist watches. This precaution was taken to avoid collecting samples from individuals with abnormally high tritium burdens caused by leakage of tritiated luminous compounds found in such watches (*2*). Samples were collected in 1-liter disposable plastic containers to which 1 ml of a 10 percent solution of merthiolate was added as a preservative.

Analytical procedure

Samples were returned to the National Environmental Research Center-Las Vegas for tritium analysis. The samples were then thermally distilled and added to a dioxane-base liquid scintillation cocktail and subsequently counted by liquid scintillation (*3*). Counting times were long enough to insure a detection limit of 400 pCi/liter.

Results

Table 1 lists the analytical results and the age and sex of the subjects residing in Noatak, Alaska. Figure 2 is a log-normal probability plot of tritium concentrations observed in the urine samples collected in Noatak. The mean concentration was 1,500 pCi/liter. For com-

Table 1. Tritium concentrations in the urine of Noatak residents, May 10, 1972

Sex	Age	Tritium concentration (pCi/liter)
F	10	1,300
F	11	2,300
F	12	1,000
M	14	1,600
M	14	1,300
M	15	1,000
M	23	1,900
M	23	1,600
F	31	1,500
		$\bar{x}$=1,500

[1] National Environmental Research Center—Las Vegas, Environmental Protection Agency, Las Vegas, Nev.

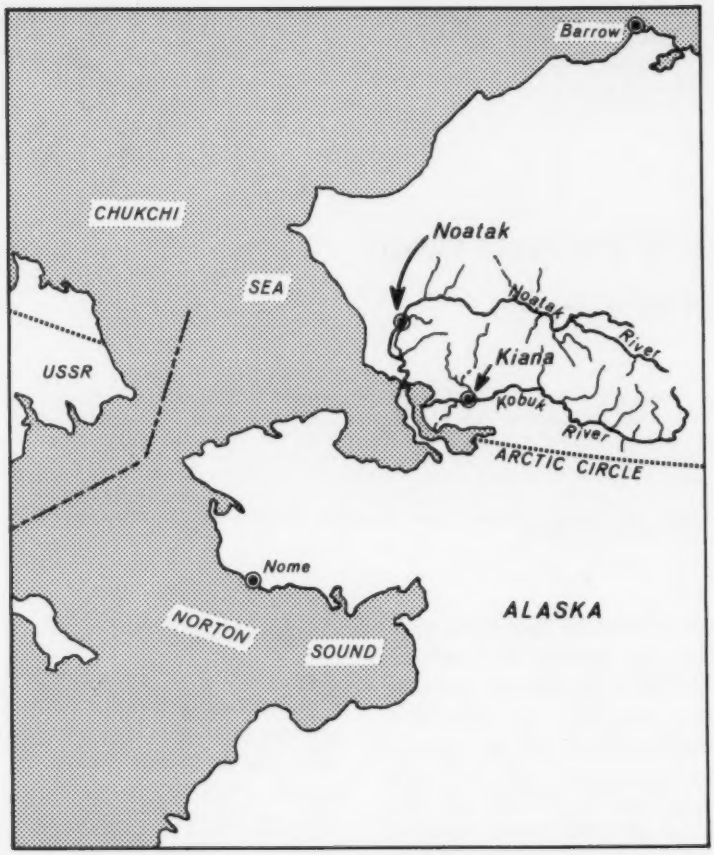

Figure 1. Location of two villages where samples were obtained

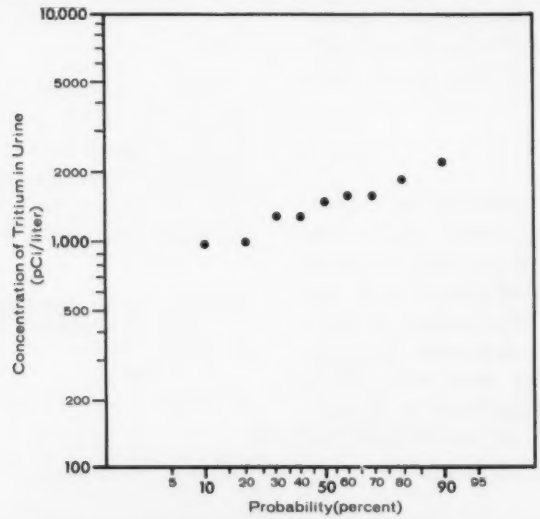

Figure 2. Probability distribution of tritium in urine of Noatak residents for May 1972

parison, the tritium concentration in the sample of village drinking water was 1,200 pCi/liter.

Analytical results, age, and sex of the subjects residing in Kiana, Alaska, are shown in table 2. Figure 3 is a log-normal probability plot of tritium concentrations observed in urine samples collected in Kiana. The mean concentration was 1,000 pCi/liter. The tritium concentration in the drinking water sample from Kiana was found to have a value of less than 400 pCi/liter, significantly lower than the mean value for urine concentration.

Table 2. Tritium concentrations in the urine of Kiana residents, May 9, 1972

Sex	Age	Tritium concentration (pCi/liter)
F	11	1,400
F	11	1,100
M	11	1,500
M	13	600
M	38	1,000
M	42	1,000
F	45	1,100
M	65	1,000
F	67	900
F	74	700
		$\bar{x}$=1,000

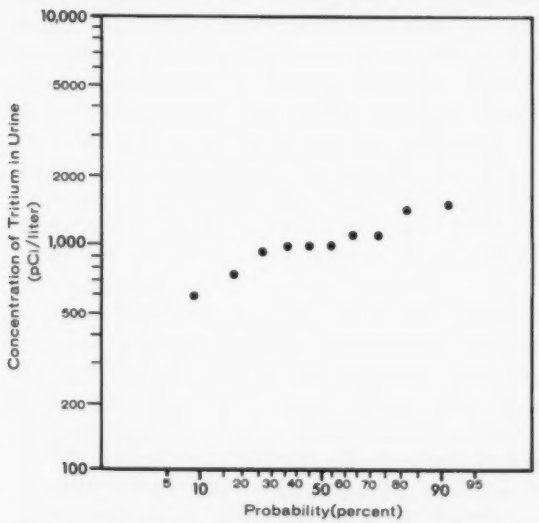

Figure 3. Probability distribution of tritium in urine of Kiana residents for May 1972

Discussion

Estimated annual doses are computed using the conversion factor (*4*):

$$DE = 0.1\ C$$

where,

DE = dose equivalent in mrem/a;
C = concentration of tritium in the body in nCi/liter

The mean urine tritium concentration for Kiana corresponds to an annual dose of 0.1 mrem. The mean tritium concentration for Noatak corresponds to an annual dose of 0.15 mrem. These values are orders of magnitude less than the applicable Federal Radiation Council Radiation Protection Guides (170 mrem/year whole-body dose from nonmedical man-made sources for a suitable sample of the general population) (*5*).

In a study conducted in South Carolina, Moghissi and Lieberman (*6*) observed a ratio between the tritium concentration in drinking water and the tritium concentration in urine of 1:0.4. Moghissi and Lieberman further concluded that the computation of doses based on drinking water tritium concentrations would lead to conservative estimates. This was not the case for the two Arctic villages. The ratio between the tritium concentration in drinking water and the concentration in urine was 1:1.25 for Noatak. The concentration in drinking water for Kiana was below the sensitivity of the analytical technique and the possibility that the result is anomalous will be investigated in subsequent sampling.

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(*2*) FITZSIMMONS, C. K., D. N. McNELIS, and D. T. WRUBLE. Tritium activity in urine from luminous dial wrist watches. Health Phys 22:514–516 (1972).

(*3*) MOGHISSI, A. A., H. L. KELLEY, J. E. REGNIER, and M. W. CARTER. Low-level counting by liquid scintillation. I. Tritium Measurements in Homogeneous Systems. Intnl J Appl Radio-Isotp 20: 145 (1969).

(*4*) MOGHISSI, A. A. and C. R. PORTER. Tritium in surface waters of the United States, 1966. Radiol Health Data Rep 9:337–339 (July 1968).

(*5*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards. Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*6*) MOGHISSI, A. A. and R. LIEBERMAN. Comparison between tritium concentration in drinking water and body water. Health Phys 22:509–511 (1972).

SECTION I. MILK AND FOOD

Milk Surveillance, January 1973

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmenal releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency) — 5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radio-

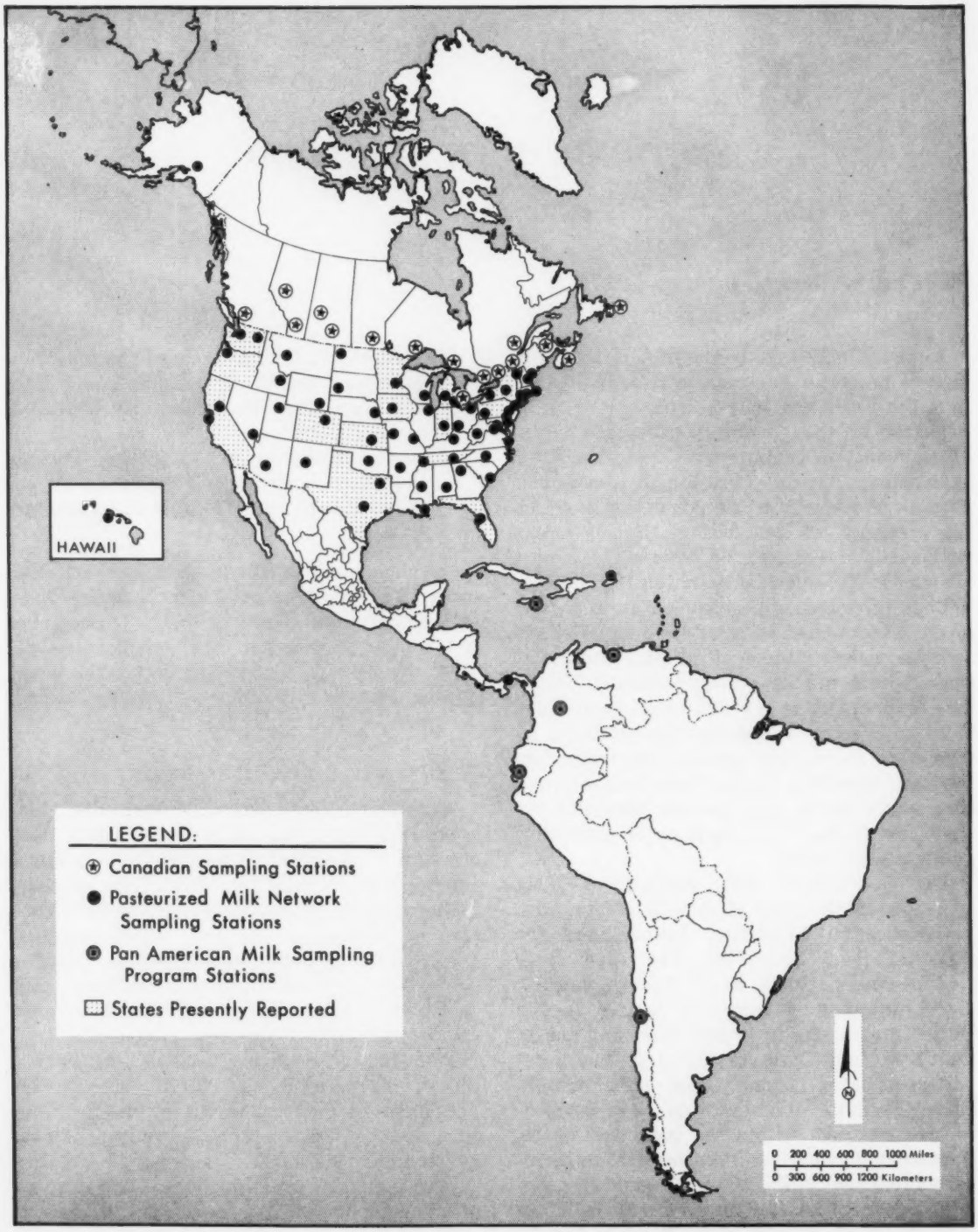
HAWAII
LEGEND:
Canadian Sampling Stations
Pasteurized Milk Network Sampling Stations
Pan American Milk Sampling Program Stations
States Presently Reported
0 200 400 600 800 1000 Miles
0 300 600 900 1200 Kilometers

Figure 1. Milk sampling networks in the Western Hemisphere

strontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 $\pm$ 0.08 g/liter for calcium and 1.51 $\pm$ 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963—March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during June 1972 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 17 laboratories producing data for the network reports in *Radiation Data and Reports*, 13 participated in this study.

The accuracy results of this study for these 13 laboratories are shown in table 1. The accuracy of the cesium-137 measurements continues to be excellent as in previous experiments. However, both the accuracy and precision need to be improved for iodine-131, strontium-89, and strontium-90 which could probably be accomplished through recalibration.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addi-

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration		Number of laboratories in each category				Experimental 2σ error (pCi/liter)
		Acceptable [a]	Warning level [b]	Unacceptable [c]	Total	
Iodine-131:	(96 or 99 pCi/liter)	7 (58%)	1 (8%)	4 (33%)	12	6
	(438 or 484 pCi/liter)	11 (85%)	0	2 (15%)	13	25 or 28
Cesium-137:	(53 or 54 pCi/liter)	11 (92%)	0	1 (8%)	12	6
	(295 or 303 pCi/liter)	11 (85%)	2 (15%)	0	13	17
Strontium-89:	(29 or 30 pCi/liter)	9 (82%)	0	2 (18%)	11	6
	(197 or 201 pCi/liter)	3 (33%)	1 (11%)	5 (56%)	9	11 or 12
Strontium-90:	(32.1 or 32.4 pCi/liter)	4 (33%)	4 (33%)	4 (33%)	12	1.9
	(150.5 or 151.2 pCi/liter)	6 (55%)	0	5 (45%)	11	8.7

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

tion, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 show whether raw or pasteurized milk was collected. An analysis (*6*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*6*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and is used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2-standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥ 50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥20 pCi/liter;
Iodine-131, Cesium-137, Barium-140	4-10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the February 1973 issue of *Radiation Data and Reports.*

Data reporting format

Table 2 presents the integratetd results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported in *Radiation Data and Reports.* The relationship between the PMN stations and the State stations is shown

Table 2. Concentrations of radionuclides in milk for January 1973 and 12-month period February 1972 through January 1973

Sampling location		Type of sample [a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:						
Ala:	Montgomery [c]	P	6	5	0	6
Alaska:	Palmer [c]	P	3	4	0	6
Ariz:	Phoenix [c]	P	0	0	0	0
Ark:	Little Rock [c]	P	6	10	0	4
Calif:	Sacramento [c]	P	0	1	0	0
	San Francisco [c]	P	0	0	0	0
	Del Norte	P	10	11	14	8
	Fresno	P	0	1	0	3
	Humboldt	P	3	3	0	4
	Los Angeles	P	0	1	0	2
	Mendocino	P	0	3	0	5
	Sacramento	P	0	2	0	4
	San Diego	P	0	1	0	4
	Santa Clara	P	0	1	0	4
	Shasta	P	2	2	0	6
	Sonoma	P	2	2	0	4
Colo:	Denver [c]	P	3	3	0	1
	East	R	NA	NA	0	3
	Northeast	R	NS	NA	NS	1
	Northwest	R	NS	NA	NS	0
	South Central	R	NS	NS	NS	NS
	Southeast	R	NS	NA	NS	0
	Southwest	R	NA	NA	[d] 0	2
	West	R	NS	NA	NS	4
Conn:	Hartford [c]	P	5	5	0	6
	Central	P	7	7	14	13
Del:	Wilmington [c]	P	4	3	0	7
D.C:	Washington [c]	P	4	6	0	5
Fla:	Tampa [c]	P	4	5	34	36
	Central	R	NS	5	NS	43
	North	R	8	6	12	14
	Northeast	R	7	5	22	32
	Southeast	R	5	5	63	53
	Tampa Bay area	P	6	5	23	35
	West	R	10	3	0	13
Ga:	Atlanta [c]	P	NS	9	NS	10
Hawaii:	Honolulu [c]	P	0	2	0	1
Idaho:	Idaho Falls [c]	P	3	4	0	0
Ill:	Chicago [c]	P	3	5	0	3
Ind:	Indianapolis [c]	P	3	5	0	3
	Central	P	6	7	10	10
	Northeast	P	6	6	0	10
	Northwest	P	7	3	10	11
	Southeast	P	5	3	0	9
	Southwest	P	6	7	10	11
Iowa:	Des Moines [c]	P	5	4	0	0
	Iowa City	P	NS	7	0	7
	Des Moines	P	4	6	0 (2)	5
	Little Cedar	P	NS	7	0	7
	Le Mars	P	NS	3	12	6
Kans:	Wichita [c]	P	6	6	0	0
	Coffeyville	P	NA		0	9
	Dodge City	P	NA		0	6
	Falls City, Nebr	R	NA		0	7
	Hays	P	NA		0	7
	Kansas City	P	NA		14	8
	Topeka	P	NA		0	7
	Wichita	P	NA		0	5
Ky:	Louisville [c]	P	5	7	0	4
La:	New Orleans [c]	P	7	12	0	3
Maine:	Portland [c]	P	7	6	13	22
Md:	Baltimore [c]	P	5	6	0	6
Mass:	Boston [c]	P	4	6	14	14
Mich:	Detroit [c]	P	6	7	0	7
	Grand Rapids [c]	P	7	7	0	5
	Bay City	P	0	3	0	6
	Charlevoix	P	0	4	0	9
	Detroit	P	4	3	0	7
	Grand Rapids	P	0	3	0	7
	Lansing	P	0	3	0	8
	Marquette	P	0	4	15	17
	Monroe	P	0	2	0	4
	South Haven	P	5	4	0	7
Minn:	Minneapolis [c]	P	7	7	0	14
	Bemidji	P	8	7	12	17
	Duluth	P	15	15	19	25
	Fergus Falls	P	8	7	10	13
	Little Falls	P	15	17	16	39
	Mankato	P	4	5	12	11
	Marshall	P	3	5	5	12

See footnotes at end of table.

Table 2. Concentrations of radionuclides in milk for January 1973 and 12-month period February 1972 through January 1973—continued

Sampling location	Type of sample [a]	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average [b]	12-month average	Monthly average [b]	12-month average
UNITED STATES:					
Minn:—continued					
Minneapolis	P	9	10	9	14
Rochester	P	7	7	4	16
Miss: Jackson [c]	P	8	9	0	7
Mo: Kansas City [c]	P	5	5	0	1
St. Louis [c]	P	6	6	0	2
Mont: Helena [c]	P	3	4	0	2
Nebr: Omaha [c]	P	4	5	0	1
Nev: Las Vegas [c]	P	0	1	0	0
N.H: Manchester [c]	P	10	8	0	14
N.J: Trenton [c]	P	6	7	0	6
N. Mex: Albuquerque [c]	P	0	1	0	0
N.Y: Buffalo [c]	P	3	5	0	4
New York City [c]	P	7	8	0	6
Syracuse [c]	P	7	6	0	6
Albany	P	2	5	0 (5)	0
Buffalo	P	5	6	0	0
Massena	P	NS	7	NS	0
New York City	P	4	6	10	0
Syracuse	P	6	4	NA	0
N.C: Charlotte [c]	P	6	8	8 (2)	6
N. Dak: Minot [c]	P	9	9	0	5
Ohio: Cincinnati [c]	P	3	5	0	4
Cleveland [c]	P	5	6	0	6
Okla: Oklahoma City [c]	P	4	5	0	2
Oreg: Portland [c]	P	0	4	0	3
Baker	P	NA		NA	
Coos Bay	P	NA		NA	
Eugene	P	NA		NA	
Medford	P	NA		NA	
Portland composite	P	NA		NA	
Portland local	P	NA		NA	
Redmond	P	NA		NA	
Tillamook	P	NA		NA	
Pa: Philadelphia [c]	P	4	6	0	3
Pittsburgh [c]	P	7	8	0	8
Dauphin	P	3	4	0	8
Erie	P	5	6	0	7
Philadelphia	P	0	5	12	8
Pittsburgh	P	5	7	0	10
R.I: Providence [c]	P	6	6	14	10
S.C: Charleston [c]	P	8	8	0	12
S. Dak: Rapid City [c]	P	3	5	0	1
Tenn: Chattanooga [c]	P	5	8	11	8
Memphis [c]	P	6	7	0	1
Chattanooga	P	9	10	0	11
Clinton	P	4	9	6 (2)	13
Fayetteville	R	7	10	13 (3)	8
Kingston	R	7	10	0	7
Knoxville	P	5	8	5 (2)	7
Lawrenceburg	R	6	8	0	9
Nashville	P	7	8	0	6
Pulaski	R	6	6	4	8
Sequoyah	R	NS	8	NS	15
Tex: Austin [c]	P	0	2	0	0
Dallas [c]	P	3	5	0	0
Amarillo	R	NS	3	NS	0
Corpus Christi	R	NS	4	NS	0
El Paso	R	NS	2	NS	0
Fort Worth	R	4	4	0	0
Harlingen	R	7	5	0	0
Houston	R	7	8	0	0
Lubbock	R	NS	3	NS	0
Midland	R	NS	2	NS	0
San Antonio	R	4	4	0	0
Texarkana	R	NS	13	NS	0
Tyler	R	15	15	0	0
Uvalde	R	NS	—	NS	—
Wichita Falls	R	NS	5	NS	0
Utah: Salt Lake City [c]	P	2	3	12	3
Vt: Burlington [c]	P	3	5	0	11
Va: Norfolk [c]	P	6	6	16	7
Wash: Seattle [c]	P	4	3	0	1
Spokane [c]	P	4	4	0	5
Benton County	R	3	1	0	0
Franklin County	R	NS	1	NS	0
Longview	R	0	4	0	2
Sandpoint, Idaho	R	6	8	0	9
Skagit County	R	5	7	0	4
W. Va: Charleston [c]	P	5	7	0	5
Wisc: Milwaukee [c]	P	NS	5	NS	7
Wyo: Laramie [c]	P	0	2	0	0

See footnotes at end of table.

Table 2. Concentration of radionuclides in milk for January 1973 and 12-month period February 1972 through January 1973—continued

Sampling location	Type of sample [a]	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average [b]	12-month average	Monthly average [b]	12-month average
CANADA:					
Alberta: Calgary	P	NA		13	14
Edmonton	P	NA		11	19
British Columbia: Vancouver	P	NA		13	19
Manitoba: Winnipeg	P	NA		11	16
New Brunswick: Moncton	P	NA		9	8
Newfoundland: St. John's	P	NA		14	23
Nova Scotia: Halifax	P	NA		7	15
Ontario: Ottawa	P	NA		6	10
Sault Ste. Marie	P	NA		17	22
Thunder Bay	P	NA		13	19
Toronto	P	NA		13	9
Windsor	P	NA		5	7
Quebec: Montreal	P	NA		10	10
Quebec	P	NA		14	20
Saskatchewan: Regina	P	NA		8	12
Saskatoon	P	NA		7	13
CENTRAL AND SOUTH AMERICA:					
Canal Zone: Cristobal [c]	P	0	1	11	10
Chile: Santiago	P	0	1	0	1
Colombia: Bogota	P	0	1	0	0
Ecuador: Guayaquil	P	0	0	0	0
Jamaica: Montego Bay	P	NS	2	NS	48
Puerto Rico: San Juan [c]	P	0	1	0	3
Venezuela: Caracas	P	NS	0	NS	0
PMN network average [c]		4	5	2	5

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] The practical reporting level for this network differs from the general ones given in the text. Sampling results for these networks were equal to or less than the following practical reporting levels:
Cesium–137: Colorado—25 pCi/liter; Oregon—15 pCi/liter.

[e] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].

NA, no analysis.
NS, no sample collected.

in figure 2. The first column in table 2 under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply; the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for January 1973 and the 12-month period, February 1972 to January 1973. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from

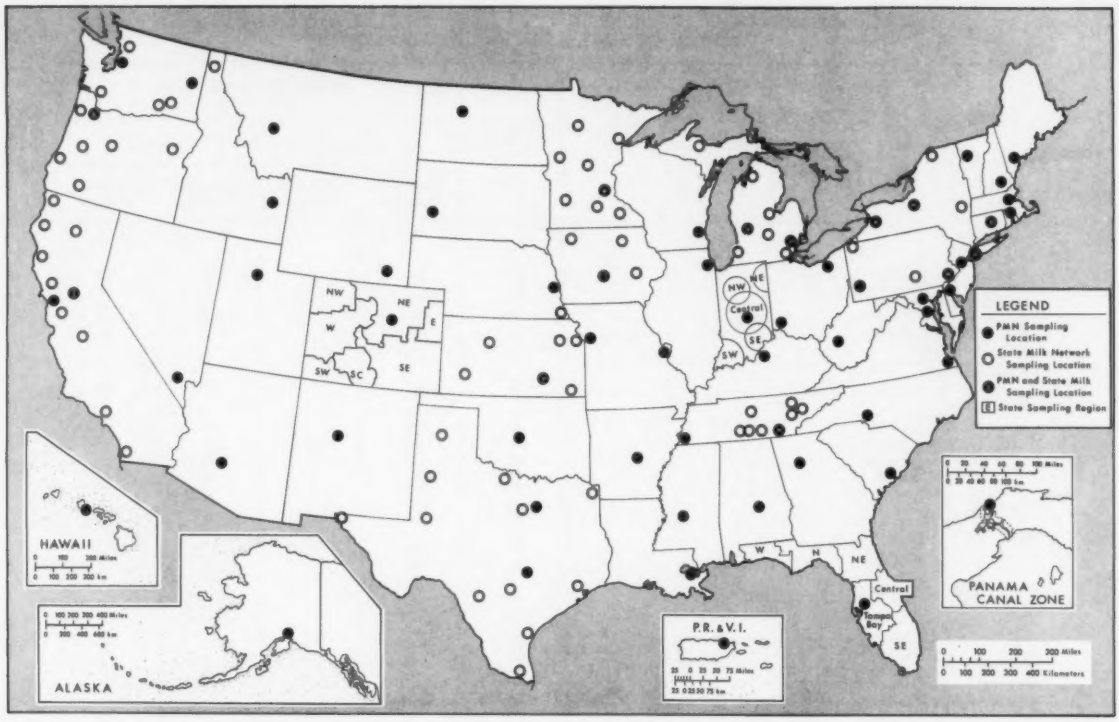

Figure 2. State and PMN milk sampling stations in the United States

table 2 since levels at the majority of the stations for January 1973 were below the respective practical reporting levels. Table 3 gives monthly averages for those stations at which strontium-89, iodine-131, and barium-140 were detected.

Table 3. Strontium-89, iodine-131, and barium-140 in milk, January 1973 [a]

Sampling location		Iodine-131 (pCi/liter)	Barium-140 (pCi/liter)
Fla:	Northeast (State)	11	
	North (State)		15
	Southeast (State)		17
	West (State)		16
Tenn:	Pulaski (State)	10	

[a] Strontium-89: 6pCi/liter for Santiago, Chile (PAHO).

Strontium-90 monthly averages ranged from 0 to 15 pCi/liter in the United States for January 1973, and the highest 12-month average was 17 pCi/liter (Little Falls, Minn.) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 63 pCi/liter in the United States for January 1973, and the highest 12-month average was 53 pCi/liter (southeast Florida) representing 1.5 percent of the value derived from the recommendations given in the Federal Radiation Council Report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data from their milk surveillance networks:

Bureau of Radiological Health
Environmental Health & Consumer Protection Program
California Department of Public Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

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Milk Surveillance Programs, November 1972

National Environmental Research Center—Las Vegas, Environmental Protection Agency

The Milk Surveillance Network, operated by the National Environmental Research Center-Las Vegas (NERC-LV)[1] consists of 30 sampling locations (figure 1) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing programs sponsored by the U.S. Atomic Energy Commission (AEC) and by the Space Nuclear Systems Office, National Aeronautical and Space Administration.

In the event of a release of radioactivity from the NTS, special sampling within the affected

[1] This network is operated under a Memorandum of Understanding (No. AT (26–1)–539 with the Nevada Operations Office, AEC, Las Vegas, Nev.

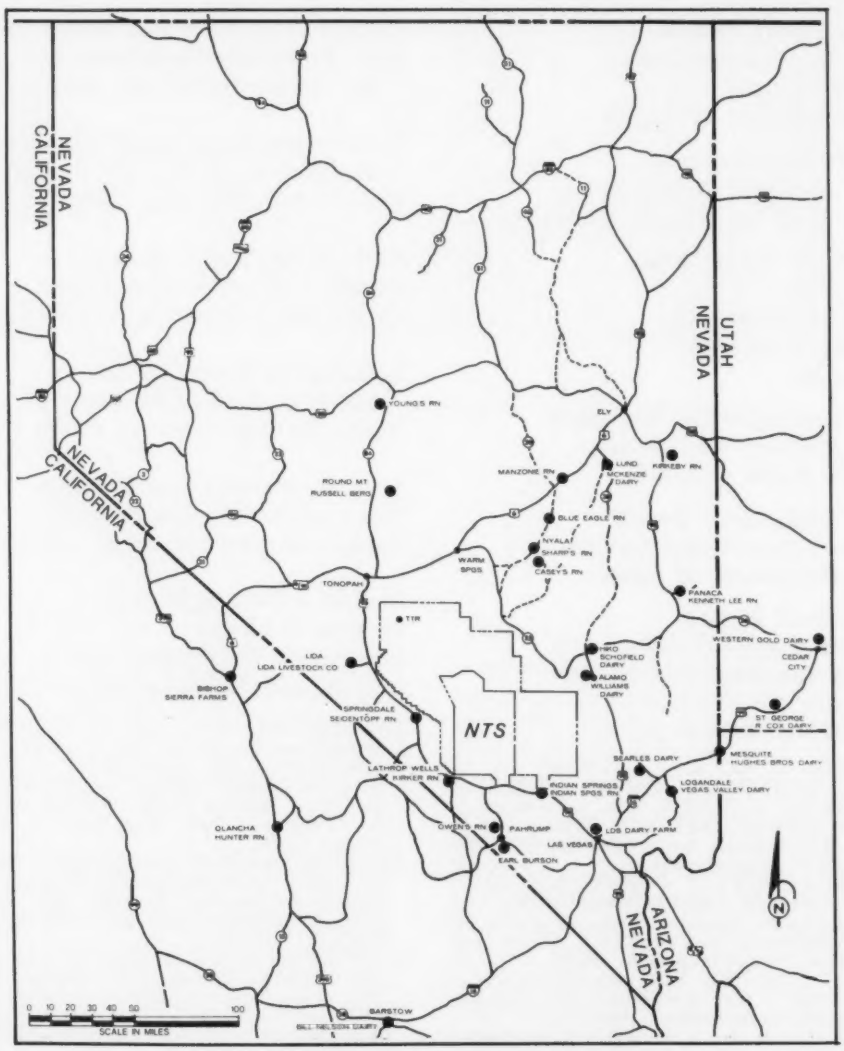

Figure 1. NERC-LV Milk Surveillance Network

area is conducted to determine radionuclide concentrations and to take protective action, if required. Additional milk sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and analytical procedures was included with the milk results reported in the December 1972 issue of *Radiation Data and Reports.*

Results

The analytical results of all milk samples collected in November 1972 by NERC-LV surveillance programs are listed in table 1. With the exception of cesium-137 at levels near the minimum detectable activity (MDA) of 10 pCi/liter, no gamma-emitting fission products were identified by gama spectrometry in any of the samples collected in November. Levels of trit-

Table 1. Milk surveillance results, November 1972

Location	Map number	Date collected (1972)	Sample type [a]	Radionuclide concentrations [b] (pCi/liter)			
				^{137}Cs	^{89}Sr	^{90}Sr	^{3}H
California:							
Bishop:							
Sierra Farms	5	14	11	<10	<2.0	<1.3	NA
Hinkley:							
Bill Nelson Dairy	13	13	12	<10	<2.0	1.5± 1.0	NA
Independence:							
Smith Ranch	14	14	13	<10	<2.0	2.0± 1.2	NA
Nevada:							
Alamo:							
Williams Dairy	1	1	12	<10	<2.0	<1.0	NA
Austin:							
Young's Ranch	3	1	13	<10	<2.0	2.4± 1.4	NA
Belmont:							
Pine Creek Ranch	4	1	13	10	<4.0	8.0± 2.0	NA
Caliente:							
Tennille Ranch	6	2	13	<10	<2.0	4.0± 2.0	NA
Currant:							
Blue Eagle Ranch	7	15	13	<10	<2.0	2.0± 2.0	NA
Eureka:							
Martin Ranch	10	1	13	20	<4.0	5.3± 2.4	NA
Hiko:							
Schofield Dairy	12	1	12	<10	<2.0	1.6± 1.3	<210
Indian Springs:							
Indian Springs Ranch	15	2	13	<10	<2.0	4.0± 1.0	NA
Las Vegas:							
Anderson Dairy	17	7	11	<10	<2.0	2.2± 1.3	NA
Arden Dairy	18	7	11	<10	<2.0	2.2± 1.3	NA
LDS Dairy Farms	19	7	12	<10	<2.0	2.9± 1.5	<240
Lida:							
Lida Livestock Company	21	1	13	<10	<2.0	2.1± 1.2	NA
Logandale:							
Vegas Vally Dairy	22	1	12	<10	<2.0	<1.0	NA
Lund:							
McKenzie Dairy	23	15	12	<10	<2.0	<1.0	<190
McGill:							
Larsen Ranch	24	14	13	<10	<2.0	<1.0	NA
Mesquite:							
Hughes Bros. Dairy	25	1	12	<10	<2.0	2.0± 1.0	210±190
Moapa:							
Searles Dairy	26	1	12	<10	<2.0	<1.0	NA
Nyala:							
Sharp's Ranch	28	14	13	<10	NA	NA	<190
Pahrump:							
Owens Ranch	31	2	13	<10	NA	NA	NA
Panaca:							
Kenneth Lee Ranch	33	2	13	<10	<2.0	3.3± 1.3	NA
Shoshone:							
Kirkeby Ranch	35	13	13	<10	<2.0	<2.0	NA
Springdale:							
Seidentopf Ranch	36	2	13	<10	<2.0	2.0± 1.0	NA
Utah:							
Garrison:							
Gonders Ranch	11	14	13	<10	<2.0	2.0± 1.0	NA
Newcastle:							
Newcastle Dairy	27	2	12	<10	<2.0	<1.0	NA
St. George:							
R. Cox Dairy	37	2	12	<10	<2.0	2.0± 1.0	NA

[a] 11—pasteurized milk.
12—Raw milk from Grade A producer(s).
13—raw milk from family cow(s).
[b] Two-sigma counting error provided when available.
NA, not analyzed.

ium and strontium-90 near the MDA's for these radionuclides (~200 pCi/liter and ≅1 pCi/liter, respectively) were also measured by radiochemistry analyses. Copies of these results were distrbuted to EPiA Regonal Offices and appropriate State agencies prior to publication.

Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intake of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	January–June 1971	December 1972
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Institutional Total Diet	October–December 1971 and 1971 Annual Summary	June 1972
Radiostrontium in Milk	January December 1971	November 1972
Strontium-90 in Tri-City Diets	January December 1971	December 1972

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2-4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence [1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
California	January–December 1970	June 1972
Colorado River Basin	1968	March 1972
Community Water Supply Study	1969	September 1972
Florida	1969	January 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1971	February 1973
Michigan	January–June 1970	November 1971
Minnesota	July 1970–June 1971	November 1972
New York	July–December 1970 and January–June 1971	May 1972
North Carolina	1968–1970	September 1972
Radiostrontium in Tap Water, *HASL*	July–December 1971	November 1972
Tritium Surveillance System	July–September 1972	February 1973
Washington	July 1969–June 1970	March 1972
Water Surveillance Programs, *NERC-LV*	October 1972	April 1973

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Water Surveillance Programs, November 1972

National Environmental Research Center—
Las Vegas, Environmental Protection Agency

The Water Surveillance Network,[1] operated by the National Environmental Research Center-Las Vegas (NERC-LV), consists of 90 sampling locations (figures 1 and 2) situated in the offsite area surrounding the Nevada Test Site (NTS). This routine network is operated in support of the nuclear testing programs sponsored by the U.S. Atomic Energy Commission (AEC) and by the Space Nuclear Systems Office, National Aeronautical and Space Administration.

[1] This network is operated under a Memorandum of Understanding (No. AT (26-1)-539) with the Nevada Operations Office, AEC, Las Vegas, Nev.

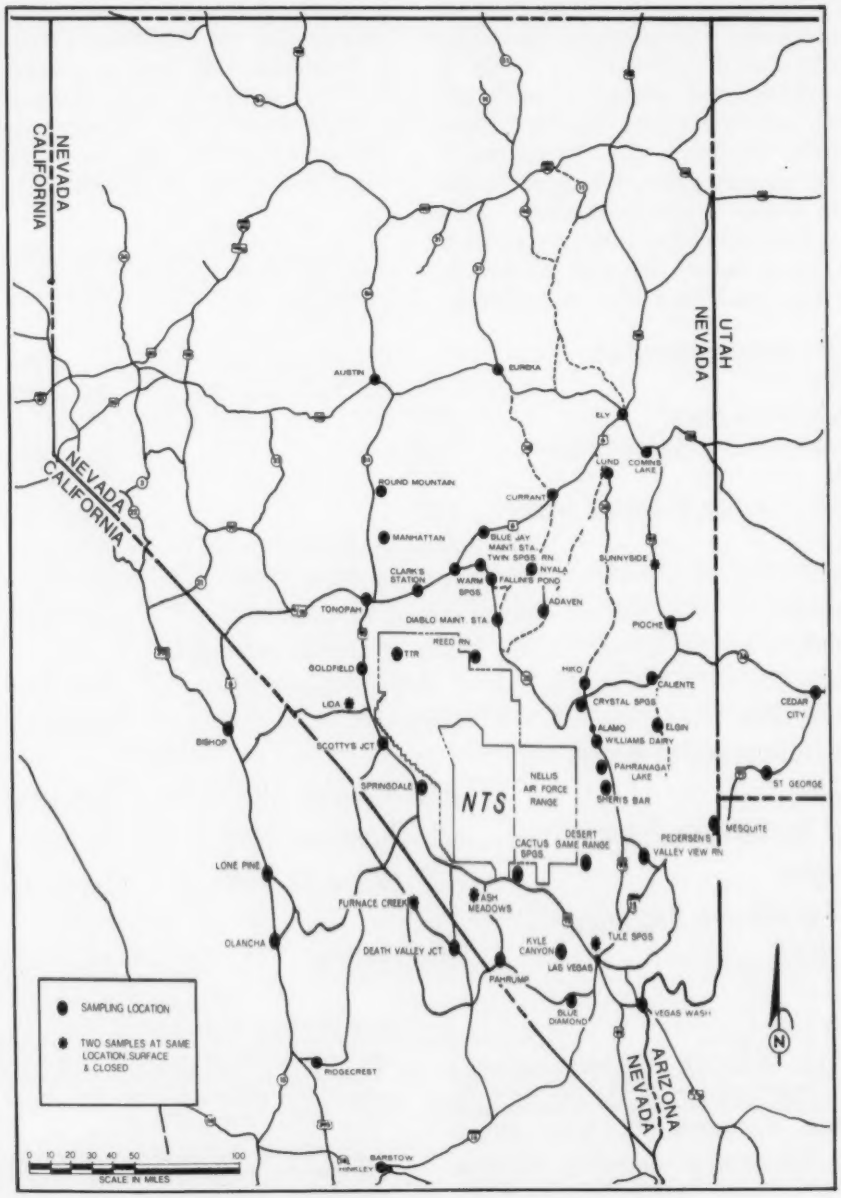

Figure 1. NERC-LV Water Surveillance Network

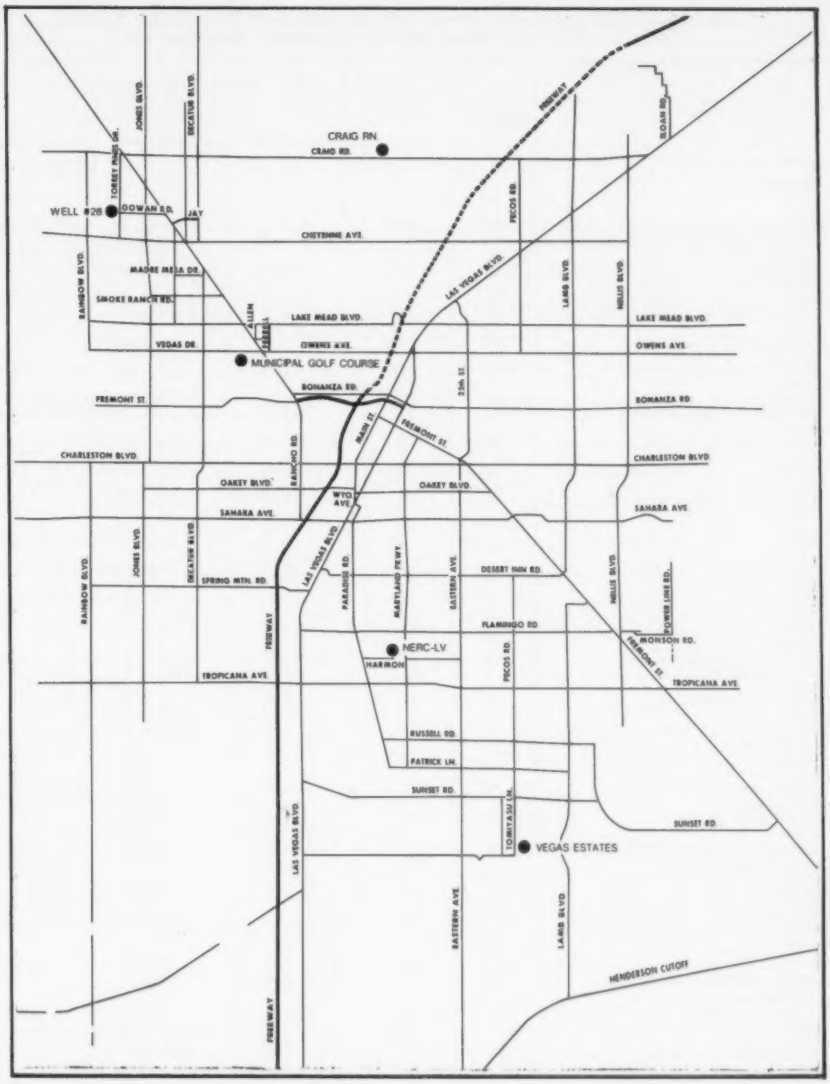

Figure 2. Water Surveillance Network—Las Vegas Valley

In the event of a release of radioactivity from the NTS, special sampling within the affected area is conducted to determine radionuclide concentrations and to take protective action, if required. Additional water sampling networks are operated in support of AEC operations in areas other than the NTS when requested. A complete description of sampling and routine analytical procedures was included with the water results reported in the December 1972 issue of *Radiation Data and Reports.*

For the purpose of identifying the source of the gross radioactivity in all network samples, and comparing sample concentrations with both the AEC Concentration Guides and the PHS Drinking Water Standards, selected samples from each sampling location are given special analyses at least once a year beginning with calendar year 1972. For surface water samples, the special analyses includes strontium-89, strontium-90, plutonium-238, plutonium-239, uranium, and radium-226. For drinking water

Table 1. NERC-LV water surveillance results, November 1972

Location	Data collected 1972	Sample type [a]	Radioactivity concentration [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
California:					
Bishop:					
Fish and Game Office	14	23	<1.6	<3.4	NA
Owens River, 3 miles east	14	22	4.2± 3.8	5.4± 3.6	NA
Death Valley Junction:					
Lila's Cafe	15	24	<5.3	9.5± 4.0	<210
Furnace Creek:					
Pond	15	21	<4.8	9.2± 3.9	NA
Visitors Center	15	24	<5.2	9.4±.4.0	NA
Hinkley:					
Bill Nelson Dairy	13	23	11± 7.2	5.6± 3.7	NA
Little Lake:					
Little Lake Ranch	13	21	<7.7	32± 5.2	NA
Lone Pine:					
Diaz Lake	14	21	26± 10	41± 5.5	NA
Forest Service Ranger Station	14	23	<2.1	<3.5	NA
Olancha:					
Haiwee Reservoir	13	21	9.0± 4.8	8.7± 3.6	NA
Ridgecrest:					
City Hall	13	23	<3.2	5.4± 3.6	NA
Shoshone:					
Chevron Service Station	14	27	<4.5	17± 4.4	NA
Nevada:					
Adaven:					
Canfield Ranch	14	22	<3.5	<3.7	NA
Alamo:					
Sheri's Bar	1	23	<4.5	<3.8	NA
Pahranagat Lake	1	21	22± 9.3	22± 4.9	NA
Williams Dairy	1	23	<6.1	9.0± 4.0	NA
Ash Meadows:					
Ash Meadows Lodge	1	23	10± 7.9	16± 4.6	<220
Ash Meadows Pond	1	21	<7.5	15± 4.7	NA
Austin:					
County Courthouse	1	27	<3.8	15± 4.5	NA
Beatty:					
Richfield Service Station	1	23	10± 6.8	8.0± 4.0	<220
Blue Diamond:					
Post Office	1	23	<5.3	<4.0	<240
Blue Jay Highway:					
Maintenance Station	14	23	<4.1	<3.7	NA
Cactus Springs:					
Mobil Service Station	2	27	<3.5	<3.9	<240
Caliente:					
Agricultural Extension Station	2	23	7.0± 5.0	<3.8	NA
Meadow Valley Wash	2	22	<6.3	<3.9	NA
Clark Station:					
Five Mile Ranch	14	27	<4.1	<3.7	NA
Coyote Summit:					
Sand Spring Well	4	23	41±11	21± 4.7	NA
Currant:					
Currant Pond	15	21	5.0± 4.0	<3.7	NA
Currant Ranch Cafe	15	27	5.0± 4.0	<3.7	NA
Diablo Highway:					
Maintenance Station	14	23	<4.2	<3.7	NA
Diablo:					
Reed Ranch	13	21	15± 7.0	18± 4.5	NA
Elgin:					
Water tower	2	23	8.0± 6.0	9.0± 4.0	NA
Ely:					
Chevron Service Station	14	24	3.0± 3.0	<3.7	NA
Comins Lake	13	21	9.0± 6.0	29± 5.0	NA
Eureka:					
Chevron Service Station	14	24	<3.9	<3.7	NA
Glendale:					
Chevron Service Station	1	27	<5.1	7.0± 4.0	NA
Muddy River	1	22	19± 8.0	25± 5.0	NA
Goldfield:					
Alkali Springs	2	21	<9.7	18± 5.1	NA
Chevron Service Station	2	23	<5.6	<4.0	NA
Hiko:					
Crystal Springs	1	27	4.0± 4.0	5.0± 4.0	NA
Schofield Dairy	1	23	20± 8.4	26± 5.0	NA
Indian Springs:					
Chevron Service Station	2	23	<4.1	<3.9	<220
Las Vegas:					
Cal-Nev Jet Fuels	6	23	<3.5	<3.7	<220
Craig Ranch Golf Course	6	23	<3.5	5.0± 4.0	<220
Cunningham Ranch	6	23	<3.3	<3.7	<220
Desert Game Range	2	23	<3.8	<3.9	<220
Desert Game Range Pond	2	21	<3.9	<3.9	<220
Francis Residence	6	23	<5.7	<3.8	<220
Lab II, NERC-LV	6	24	<5.9	6.0± 4.0	880± 230
Lake Mead Vegas Wash	6	21	<6.0	5.0± 4.0	770± 230

See footnotes at end of table.

Table 1. NERC-LV water surveillance results, November 1972—continued

Location	Data collected 1972	Sample type [a]	Radioactivity concentration [b] (pCi/liter)		
			Gross alpha	Gross beta	Tritium
Nevada—continued					
Las Vegas:					
LDS Dairy Farm	7	23	<8.9	4.0± 4.0	<220
Lloyd Ranch	6	23	<6.0	<3.8	<220
LV Water District Well 28	6	23	<3.3	<3.7	<220
Municipal Golf Course	6	23	<3.4	<3.7	<220
Tule Springs	2	23	<3.8	<3.9	<220
Tule Springs Pond	2	21	<3.6	<3.9	NA
Vegas Estates	6	23	<6.6	7.0± 4.0	<220
Lathrop Wells:					
Texaco Service Station	1	23	<5.2	<4.0	<220
Lida Junction:					
Cottontail Ranch	1	23	<5.2	9.0± 4.0	NA
Lida:					
Lida Livestock Company	1	27	<4.5	<3.8	NA
Pond at storage tank	1	21	<4.3	<4.0	NA
Lund:					
Gardner Grocery	15	23	4.3± 3.6	<3.5	NA
Manhattan:					
Country Store	2	23	12± 6.9	7.0± 4.0	NA
Seyler Reservoir	1	21	12± 6.9	25± 5.0	NA
Mercury:					
Groom Lake	13	23	<4.2	<3.7	NA
Moapa:					
Pedersen Valley View Ranch	1	27	8.0± 5.0	9.0± 4.0	NA
Mt. Charleston:					
Kyle Canyon Fire Station	2	27	<4.0	<3.9	<220
Nyala:					
Sharp's Ranch	14	23	<3.5	<3.7	NA
Pahrump:					
Texaco Service Station	1	23	<3.7	<3.8	NA
Pioche:					
County Courthouse	2	24	<3.9	<3.8	NA
Round Mountain:					
Mobil Service Station	1	27	<3.4	<3.9	NA
Scotty's Junction:					
Chevron Service Station	1	23	<6.1	5.0± 4.0	<220
Springdale:					
Peacock Ranch	2	27	<5.4	6.0± 4.0	<220
Pond	2	21	<6.3	4.0± 4.0	NA
Sunnyside:					
Adam McGill Reservoir	15	21	7.7± 4.7	8.8± 3.8	NA
Wildlife Mgt. Headquarters	15	27	<3.2	<3.7	NA
Tonopah:					
Jerry's Chevron Station	2	23	<4.4	<4.0	NA
Tonopah Test Range CP-1	2	23	<4.4	4.0± 4.0	NA
Warm Springs:					
Fallini's Pond	14	21	24± 12	74± 7.1	NA
Hot Creek Ranch	14	27	<6.0	12± 4.3	NA
Service Station and Cafe	13	27	42± 12	36± 5.4	NA
Twin Springs Ranch	14	23	<4.1	4.0± 4.0	NA
Utah:					
Cedar City:					
M.D. Baldwin Residence	1	24	<3.6	<3.9	NA
Garrison:					
Rowley Grocery	14	23	<3.0	<3.5	NA
Newcastle:					
Municipal Reservior	1	21	<3.2	<3.9	NA
Newcastle Dairy	2	24	<5.6	<4.0	NA
St. George:					
R. Cox Dairy	2	24	<2.5	<3.9	NA

[a] 21–pond, lake, reservoir, stock tank, stock pond.
22–stream, river, creek.
23–well.
24–multiple supply-mixed water sample consisting of mixed or multiple sources of water, such as well or spring.
27–spring
[b] Two-sigma counting error provided when available.
NA, not analyzed.

samples, the analyses includes strontium-89, strontium-90, uranium, and radium-226.

Results

The routine analytical results of all water samples collected in November 1972 by the NERC-LV Water Surveillance Network are listed in table 1. No gamma-emitting fission products were identified by gamma spectrometry in any of the samples collected in November. The analytical results of samples selected for special analyses will be reported at a later date.

Copies of these results are distributed to EPA Regional Offices and appropriate State agencies prior to publication.

Tritium Surveillance System, October-December 1972

Office of Radiation Programs
Environmental Protection Agency

The Tritium Surveillance System is an expansion of previous tritium surveillance activities initiated by the Public Health Service and transferred in 1970 to the Office of Radiation Programs, Environmental Protection Agency (EPA). The principal effort in the past related to tritium releases was the Tritium in Surface Water Network. This network was established in 1964 to measure and monitor tritium concentrations in major river systems in the United States and to provide surveillance at surface water stations downstream from selected nuclear facilities. The network consisted of selected stations from the existing water pollution surveillance sampling stations. The final data from this network for January–June 1970, have been published previously (*1*).

Another sampling program of the Public Health Service was a tritium in precipitation program. This project was established in 1967 at selected Radiation Alert Network (RAN) stations covering the United States, including Alaska and Hawaii. The RAN is now operated by the Office of Air Programs of the EPA. The data from this project for July–December 1969 have been published previously (*2*). Due to the increased interest in tritium releases from nuclear facilities and the potential long-term accumulation in the environment, a national system was established to incorporate these projects or networks into one overall system.

Present network

The Tritium Surveillance System consists of 69 quarterly drinking water samples at the RAN stations, precipitation samples collected daily and analyzed monthly from 8 of the RAN stations (figure 1), and quarterly samples at 39 surface water stations (figure 2). The specific locations for the surface water sampling systems were determined by examining the water drainage areas to assure that a representative sample from a large area or region was obtained, and if possible, incorporating several nuclear facility sites. All nuclear facilities that were operating, being constructed, or planned through 1975 were considered. Consideration was also given to the current surveillance programs of the States that will be involved in the collection of the samples. The surface water samples are collected quarterly either downstream from a nuclear facility or at a background station.

The tap water samples are collected by the RAN operators on a quarterly basis. The precipitation samples are also collected by the RAN operators on a daily basis.

All samples are sent to either the Eastern Environmental Radiation Laboratory or the National Environmental Research Center—Las Vegas for analysis. Analytical values which are not statistically significant at the 2-sigma confidence level have been reported as zero.

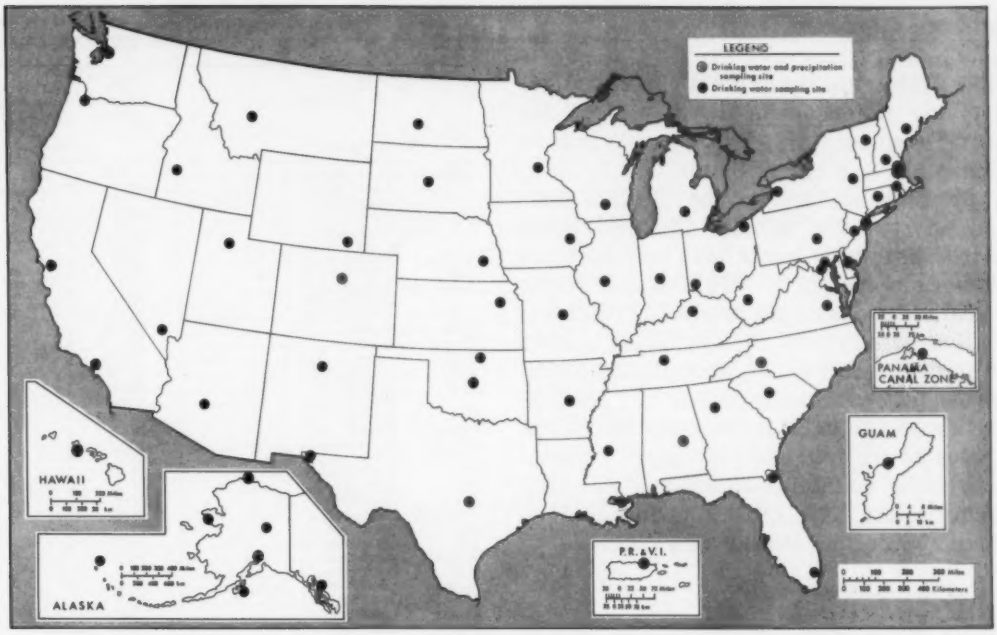

Figure 1. Drinking water and precipitation sampling locations for tritium surveillance system

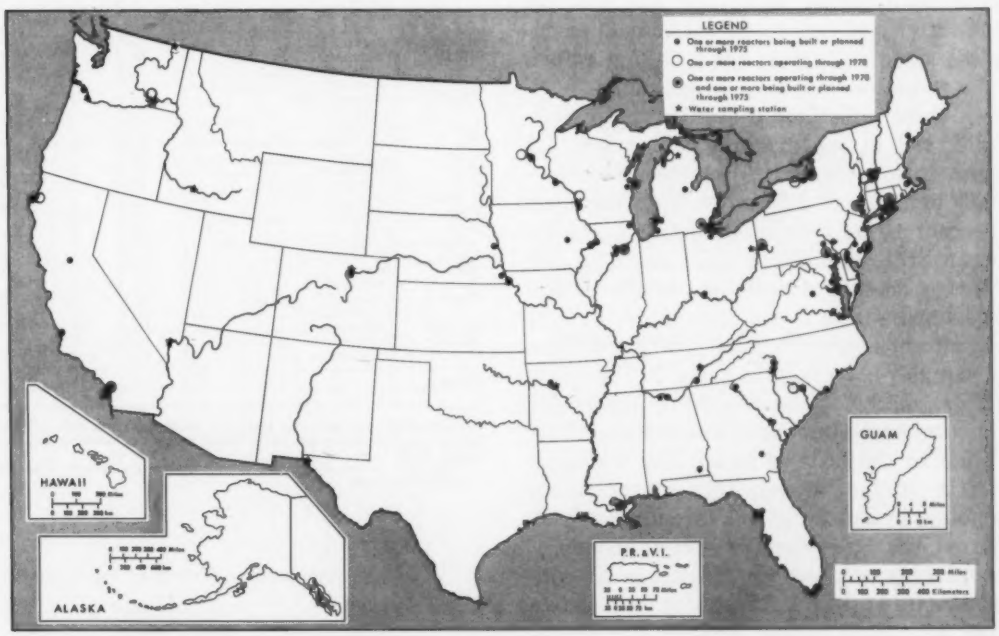
LEGEND
One or more reactors being built or planned through 1975
One or more reactors operating through 1970
One or more reactors operating through 1970 and one or more being built or planned through 1975
Water sampling station
HAWAII
ALASKA
P.R. & V.I.
GUAM

Figure 2. Surface water sampling locations for tritium surveillance system

Results and discussion

Table 1 presents the tritium concentrations in drinking water at the RAN stations for October–December 1972. The average tritium concentration was 0.2 nCi/liter.

In previous articles on the Tritium Surveillance System, the reported dose equivalents from tritium in body water have been based on a relationship derived by Moghissi and Porter (*3*). Their relationship assumed a quality factor of 1.7 for tritium beta rays based on a 1966 ICRP recommendation (*4*). Recently the NCRP has recommended a quality factor of 1 for tritium beta rays (*5*) and this recommendation has been adopted for this and subsequent reports. Following the notation adopted by the ICRU (*6*) substitution of a quality factor of 1 in Moghissi and Porter calculations yields:

$$H \text{ (mrem/year)} = 0.1C \text{ (nCi/liter)}$$

Where H is the dose equivalent rate and C represents the tritium concentration in body water.

Assuming that the concentration of tritium in all water taken into the body is equal to that found in the drinking water and also that the specific activity of tritium in the body is essentially the same as that in the drinking water, then the radiation dose may be estimated.

The highest individual concentration of tritium observed in the drinking water was 1.3 nCi/liter during the fourth quarter. This corresponds to a dose of 0.13 mrem/a, or less than 0.08 percent of the Federal Radiation Council's Radiation Protection Guide (170 mrem/a) for an average dose to a suitable sample of the exposed population.

The tritium concentrations for the surface water samples are given in table 2. The highest tritium concentration was 4.9 nCi/liter for the quarter. Assuming that the specific activity of tritium in the body is essentially the same as that in surface water, this concentration corresponds to a dose of .49 mrem/a, or 0.29 percent of the Radiation Protection Guide.

The monthly analyses for tritium in precipitation samples at the 8 RAN stations are shown in table 3.

Table 1. Tritium concentration in tap water (RAN stations) October–December 1972

Location		Date collected (1972)	Tritium concentration [a] (nCi/liter ±2σ)[b]
Ala:	Montgomery	10/3	0.0
Alaska:	Anchorage	NS	
	Attu Island	10/9	.2
	Fairbanks	NS	
	Juneau	10/5	0
	Nome	11/6	.6
	Point Barrow	10/12	.3
Ariz:	Phoenix	10/2	.3
Ark:	Little Rock	10/11	0
Calif:	Berkeley	10/2	0
	Los Angeles	10/4	0
C.Z:	Ancon	10/16	0
Colo:	Denver	10/11	.8
Conn:	Hartford	10/5	0
Del:	Dover	10/10	0
D.C:	Washington	10/13	0
Fla:	Jacksonville	10/5	0
	Miami	10/4	0
Ga:	Atlanta	10/3	.2
Guam:	Agana	10/2	0
Hawaii:	Honolulu	10/4	0
Idaho:	Boise	10/2	.5
Ill:	Springfield	10/13	.2
Ind:	Indianapolis	10/4	0
Iowa:	Iowa City	10/3	.4
Kans:	Topeka	11/6	0
Ky:	Frankfort	10/6	.3
La:	New Orleans	10/2	.5
Maine:	Augusta	10/4	0
Md:	Baltimore	10/5	.2
Mass:	Lawrence	10/5	0
	Winchester	10/4	.2
Mich:	Lansing	10/6	0
Minn:	Minneapolis	10/10	.5
Miss:	Jackson	10/3	0
Mo:	Jefferson City	10/3	0
Mont:	Helena	10/3	.6
Nebr:	Lincoln	10/4	.4
Nev:	Las Vegas	10/2	1.3 ±0.3
N.H:	Concord	10/5	.3
N.J:	Trenton	10/4	.2
N. Mex:	Santa Fe	10/2	.4
N.Y:	Albany	10/5	.2
	Buffalo	10/4	.3
	New York	10/4	.2
N.C:	Gastonia	10/4	.2
N. Dak:	Bismarck	10/17	.9
Ohio:	Cincinnati	10/4	0
	Columbus	10/5	.2
	Painesville	10/9	.3
Okla:	Oklahoma City	10/9	0
	Ponca City	10/2	.7
Ore:	Portland	10/9	0
Pa:	Harrisburg	10/6	.2
P.R:	San Juan	10/6	0
R.I:	Providence	10/12	.2
S.C:	Columbia	10/9	.3
S. Dak:	Pierre	10/2	1.1
Tenn:	Nashville	10/3	.2
Tex:	Austin	10/2	0
	El Paso	10/2	.2
Utah:	Salt Lake City	10/5	.5
Vt:	Barre	10/4	.2
Va:	Richmond	10/6	0
Wash:	Seattle	10/2	.5
	Spokane	10/3	.3
W. Va:	Charleston	10/4	0
Wisc:	Madison	10/11	0
Wyo:	Cheyenne	10/11	.8
Average			0.2

[a] The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero.

[b] The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.

NS, no sample.

Table 2. Tritium concentration in surface water, October–December 1972

Location		Water source	Facility	Collection date (1972)	Concentration [a] (nCi/liter ±2σ) [b]
Ala:	Decatur	Tennessee River	Browns Ferry	[c] 9/29	0.2
Ark:	Morrilton	Arkansas River	Arkansas Nuclear	10/11	0
Calif:	Eureka	Humboldt Bay	Humboldt Bay	NS	
	San Onofre	Pacific Ocean	San Onofre	10/1	.4
Colo:	Greely	South Platte River	Fort St. Vrain	10/13	1.0
Conn:	East Haddam	Connecticut River	Connecticut Yankee & Vermont Yankee	10/27	.5
	Waterford	Long Island Sound	Millstone	11/1	0
Fla:	Crystal River	Gulf of Mexico	Crystal River	10/5	0
	Homestead	Biscayne Bay	Turkey Point	12/6	0
Idaho:	Buhl	Snake River	National Reactor Testing Station	10/14	.4
Ill:	Moline	Mississippi River	Quad-Cities	10/31	.2
	Morris	Illinois River	Dresden and Argonne	10/18	.3
La:	New Orleans	Mississippi River	(Several)	10/5	.3
Md:	Conowingo	Susquehanna River	Peach Bottom and Three Mile Island	10/11	.2
	Lusby	Chesapeake Bay	Calvert Cliffs	10/25	.2
Mass:	Rowe	Deerfield River	Yankee	10/13	4.9
Mich:	Charlevoix	Lake Michigan	Big Rock Point	10/14	.9
	Monroe	Lake Erie	Enrico Fermi	10/16	.3
	South Haven	Lake Michigan	Palisades	10/13	0
Minn:	Monticello	Mississippi River	Monticello	10/9	.4
Nebr:	Rulo	Missouri River	Fort Calhoun and Cooper	10/4	.6
Nev:	Boulder City	Colorado River	Background	10/16	1.0
N.J:	Bayside	Delaware River	Salem	12/6	.2
N.Y:	Ossining	Hudson River	Indian Point	10/10	.3
	Oswego	Lake Ontario	Nine Mile Point and R. E. Ginna	10/10	.4
	Poughkeepsie	Hudson River	Background	10/11	.3
N.C:	Charlotte	Catawba River	Wm. B. McGuire	12/6	.3
Oreg:	Westport	Columbia River	Rainier and Hanford	10/12	.7
S.C:	Allendale	Savannah River	Savannah River Plant and Oconee	10/17	3.0
	Hartsville	Lake Robinson	H. B. Robinson	10/19	3.2
Tenn:	Kingston	Clinch River	Oak Ridge	10/31	4.3
Tex:	El Paso	Rio Grande	Los Alamos	10/2	.4
Vt:	Vernon	Connecticut River	Vermont Yankee	10/5	.2
Va:	Newport News	James River	Surry	10/13	.0
Wash:	Northport	Columbia River	Background	NS	
	Richland	Columbia River	Hanford	10/12	.7
W. Va:	Wheeling	Ohio River	Shippingport	10/11	.2
Wisc:	Two Creeks	Lake Michigan	Point Beach and Kewaunee	10/23	.4
	Victory	Mississippi River	La Crosse and Prairie Island	10/16	.2
Average					0.7

[a] The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero.
[b] The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.
[c] Sample collected early.
NS, no sample.

Table 3. Tritium concentration in precipitation from RAN stations, October–December 1972

Location		Tritium concentration [a] (nCi/liter ±2σ)		
		October	November	December
Ala:	Montgomery	0.2	0.0	0.0
Alaska:	Anchorage	NS	0	0
Colo:	Denver	NS	0	0
Hawaii:	Honolulu	0	0	0
La:	New Orleans	0	0	0
N.C:	Gastonia	0	0	0
Tex:	Austin	0	0	0
Wash:	Seattle	0	0	0

[a] The minimum detection limit for these samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero. The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.
NS, no sample.

Other coverage in *Radiation Data and Reports:*

Period	Issue
January–March 1972	August 1972
April–June 1972	January 1973
July–September 1972	February 1973

REFERENCES

(1) BUREAU OF RADIOLOGICAL HEALTH. Tritium in surface water network, January-June 1970. Radiol Health Data Rep 11: 638–639 (November 1970).

(2) BUREAU OF RADIOLOGICAL HEALTH. Tritium in precipitation (RAN), July–December 1969. Radiol Health Data Rep 11: 354–355 (July 1970).

(3) MOGHISSI, A. A. and C. R. PORTER. Tritium in surface waters in the United States, 1966. Radiol Health Data Rep 9: 337–339 (July 1968).

(4) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendations of the International Commission on Radiological Protection (Adopted September 17, 1965), ICRP Publication 9 (1969).

(5) NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS. Basic Radiation Protection Criteria, NCRP Report No. 39, National Council on Radiation Protection and Measurements, Washington, D.C. 20008 (January 15, 1971).

(6) INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS. Radiation Quantities and Units, ICRU Report No. 19. Washington D.C. 20014 (July 1972).

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports.*

Network	Period	Issue
Fallout in the United States and other areas, *HASL*	January–December 1970	December 1971
Mexican air monitoring program	May–August 1972	January 1973
Plutonium in airborne particulates	July–September 1972	March 1973

1. Radiation Alert Network January 1973

Quality Assurance and Environmental Monitoring Laboratory, Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 68 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Quality Assurance and Environmental Monitoring Laboratory, EPA, Research Triangle Park, N.C. 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during January 1973.

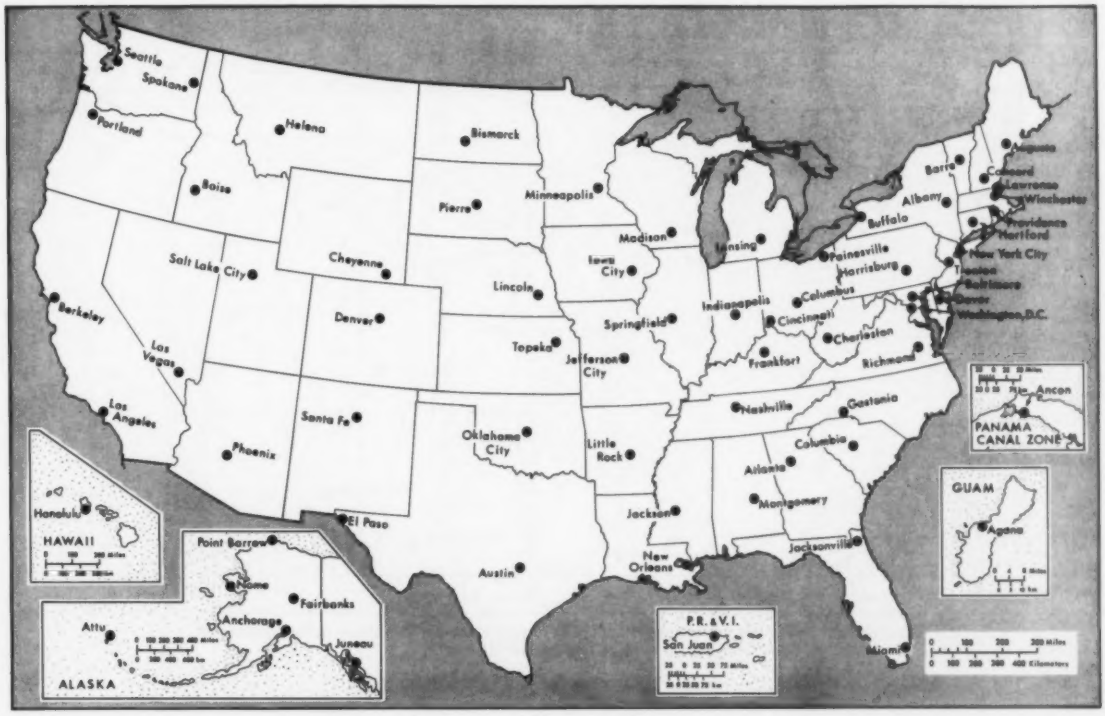

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, January 1973

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Number of samples	Precipitation			
							Field estimation of deposition			
			Maximum	Minimum	Average [a]		Total depth (mm)	Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	19	1	0	0	4	147	4	147	16
Alaska:	Anchorage	1	0	0	0	0	0			
	Attu Island	31	0	0	0	0				
	Fairbanks	0				0				
	Juneau	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	22	12	1	4	0				
Ark:	Little Rock	1	0	0	0	0				
Calif:	Berkeley	21	0	0	0	11	272	11	272	0
	Los Angeles	20	1	0	1	0				
C.Z:	Ancon	14	0	0	0	0				
Colo:	Denver	21	1	0	0	1	3	[b]		
Conn:	Hartford	21	1	0	0	7	86	7	86	0
Del:	Dover	20	1	0	0	0				
D.C:	Washington	0				0				
Fla:	Jacksonville	17	1	0	0	4	40	4	40	0
	Miami	0				0				
Ga:	Atlanta	20	1	0	0	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	21	1	0	0	3	23	[b]		
Idaho:	Boise	21	1	0	0	4	37	4	37	0
Ill:	Springfield	7	1	0	0	0				
Ind:	Indianapolis	19	1	0	0	0				
Iowa:	Iowa City	21	0	0	0	3	73	3	73	6
Kans:	Topeka	21	1	0	0	6	62	6	62	0
Ky:	Frankfort	14	1	0	1	0				
La:	New Orleans	18	1	0	0	7	70	[b]		
Maine:	Augusta	17	0	0	0	4	63	4	63	0
Md:	Baltimore	20	3	0	0	4	38	4	38	0
Mass:	Lawrence	22	0	0	0	4	96	4	96	4
	Winchester	20	1	0	0	6	113	6	113	0
Mich:	Lansing	21	0	0	0	0				
Minn:	Minneapolis	22	0	0	0	4	32	4	32	4
Miss:	Jackson	10	0	0	0	5	181	5	181	1
Mo:	Jefferson City	20	1	0	0	7	86	7	86	0
Mont:	Helena	19	2	0	1	0				
Nebr:	Lincoln	19	1	0	0	3	32	3	32	1
Nev:	Las Vegas	21	4	0	2	0				
N.H:	Concord	0				0				
N.J:	Trenton	21	1	0	0	5	78	5	78	2
N. Mex:	Santa Fe	16	1	0	0	1	4	1	4	0
N.Y:	Albany	16	2	0	1	0				
	Buffao	22	0	0	0	0				
	New York City	0				0				
N.C:	Gastonia	19	6	0	1	2	9	[b]		
N. Dak:	Bismarck	21	2	0	1	0				
Ohio:	Cincinnati	0				0				
	Columbus	2	0	0	0	0				
	Painesville	21	0	0	0	6	31	6	31	8
Okla:	Oklahoma City	0				0				
Oreg:	Portland	20	1	0	0	12	137	12	137	10
Pa:	Harrisburg	17	2	0	0	0				
P.R:	San Juan	0				0				
R.I:	Providence	19	1	0	0	0				
S.C:	Columbia	9	1	0	0	3	105	3	105	1
S. Dak:	Pierre	16	3	0	1	0				
Tenn:	Nashville	17	1	0	0	6	123	6	123	3
Tex:	Austin	20	4	0	1	6	90	[b]		
	El Paso	20	7	1	2	0				
Utah:	Salt Lake City	29	1	0	0	5	11	5	11	2
Vt:	Barre	21	1	0	0	5	59	5	59	8
Va:	Richmond	20	0	0	0	5	157	5	157	25
Wash:	Seattle	9	0	0	0	7	96	[b]		
	Spokane	19	1	0	0	0				
W. Va:	Charleston	19	2	0	0	6	34	6	34	3
Wisc:	Madison	21	0	0	0	5	71	5	71	4
Wyo:	Cheyenne	11	2	0	1	0				
Network summary		1,006	12	0	0	161	95	5	83	4

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] January 1973

Radiation Protection Division, Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Surface air and precipitation data for January 1973 are presented in table 2.

Table 2. Canadian gross beta radioactivity in air and precipitation, January 1973

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	5	0.02	0.01	0.01	41	0.1
Coral Harbour	5	.04	.03	.03	12	.1
Edmonton	5	.03	.02	.02	39	.4
Ft. Churchill	4	.01	.01	.01	25	.2
Fredericton	4	.02	.01	.02	6	.6
Goose Bay	5	.03	.02	.02	8	.2
Halifax	5	.03	.02	.02	5	.4
Inuvik	4	.06	.02	.04	11	.3
Montreal	4	.05	.02	.03	6	.4
Moosonee	5	.02	.01	.01	27	.6
Ottawa	5	.03	.01	.02	5	.4
Quebec	5	.03	.01	.02	8	.7
Regina	4	.05	.02	.03	109	.1
Resolute	5	.05	.04	.04	24	.1
St. John's, Nfld.	1	.00	<.01	.00	5	.4
Saskatoon	5	.04	.01	.01	32	.2
Sault Ste. Marie	5	.03	.02	.02	37	.6
Thunder Bay	3	.04	.02	.03	16	.4
Toronto	5	.01	.01	.01	17	.7
Vancouver	5	.01	.01	.01	6	1.0
Whitehorse	5	.06	.02	.03	NS	NS
Windsor	2	.01	.01	.01	13	.5
Winnipeg	5	.05	.02	.03	112	.3
Yellowknife	NS	NS	NS	NS	24	.3
Network summary	101	0.06	<0.01	0.02	25	0.4

NS, no sample.

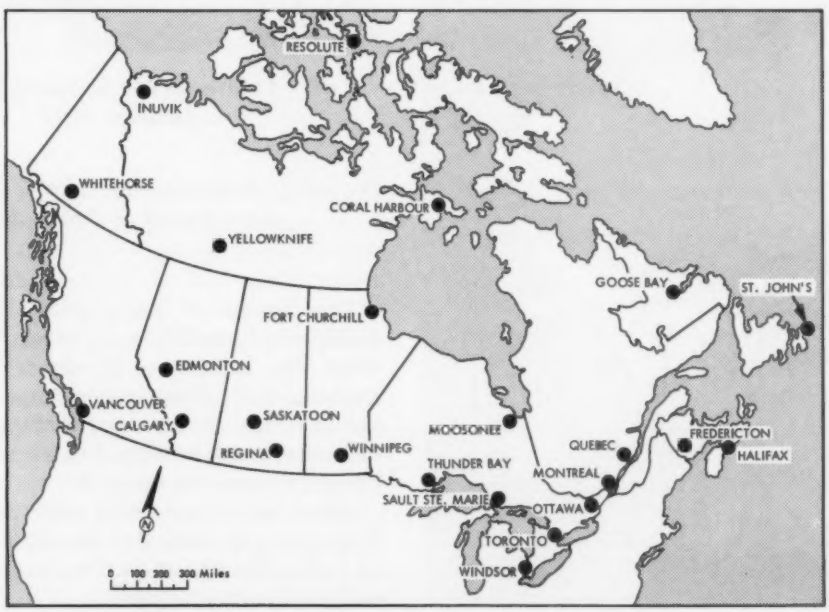

Figure 2. Canadian air and precipitation monitoring program

3. Pan American Air Sampling Program January 1973

Pan American Health Organization and U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The January 1973 air monitoring results from the participating countries are given in table 3.

Figure 3. Pan American Air Sampling Program stations

Table 3. Summary of gross beta radioactivity in Pan American surface air, January 1973

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average [a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	17	0.03	0.00	0.01
Chile:	Santiago	30	.05	.00	.03
Colombia	Bogota	22	.02	.00	.01
Ecuador:	Cuenca	1	.00	.00	.00
	Guayaquil	17	.03	.00	.01
	Quito	16	.01	.00	.00
Guyana:	Georgetown	0			
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	12	.02	.00	.01
West Indies:	Trinidad	19	.05	.00	.02
Pan American summary		134	0.05	0.00	0.01

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging 0.00 pCi/m³.

4. California Air Sampling Program January 1973

Bureau of Radiological Health, California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a con-

Figure 4. California air sampling program stations

tinuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micrometer pore size, using a Gast air pump of about 2-cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 4 presents the monthly gross beta radioactivity in air for January 1973. The monthly sample results are presented quarterly.

Table 4. Gross beta radioactivity in California air January 1973

Station location	Number of samples	Gross beta radioactivity (pCi/m³)		
		Maximum	Minimum	Average
Bakersfield	28	1.10	0.00	0.16
Barstow	20	.86	.02	.24
Berkeley	31	.10	.00	.04
Colfax	7	.07	.00	.02
El Centro	NA			
Eureka	23	.10	.00	.03
Fresno	31	.17	.01	.09
Los Angeles	31	.17	.00	.05
Redding	31	.14	.00	.03
Sacramento	31	.40	.00	.05
Salinas	31	1.00	.00	.12
San Bernardino	31	.46	.03	.13
San Diego	11	.06	.03	.04
Santa Rosa	31	.12	.00	.04
Summary	337	1.10	0.00	0.08

NA, no analysis.

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(*1*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

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(*4*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

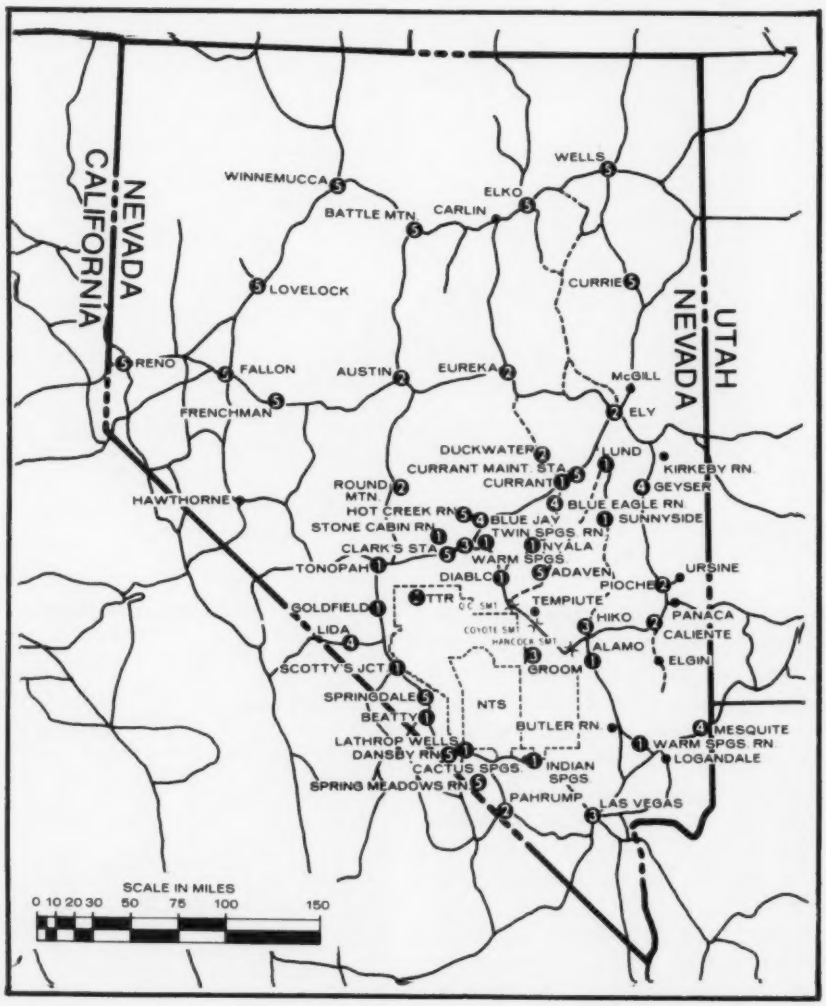

Figure 1. NERC-LV Air Surveillance Network stations in Nevada

Air Surveillance Network, January 1973

National Environmental Research Center—
Las Vegas,[1] Environmental Protection Agency

The Air Surveillance Network (ASN), operated by the National Environmental Research Center-Las Vegas (NERC-LV), consists of 49 active and 73 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS) and by the AEC at any other designated testing sites.[2]

Previously, the network consisted of 104 active and 18 standby stations. The reduction in the number of active stations was implemented this year to economize operations due to the less frequent radioactive releases at the NTS and yet provide adequate coverage in case of a release.

The stations are operated by State health department personnel and by private individuals on a contract basis. All active stations are operated continuously with filters being exchanged over periods generally ranging from 24 to 72 hours. All samples are mailed to the NERC-LV unless special retrieval is arranged at selected locations in response to known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

[1] Formerly the Western Environmental Research Laboratory.

[2] The ASN is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

Figure 2. NERC-LV Air Surveillance Network stations outside Nevada

Table 1. Summary of gross beta radioactivity concentrations in air, January 1973

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average *
Ariz:	Kingman	31	0.1	<0.1	0.1
	Seligman	31	<.1	<.1	.1
Calif:	Baker	27	.2	<.1	.1
	Barstow	31	.1	<.1	.1
	Bishop	31	<.1	<.1	.1
	Death Valley Junction	31	<.2	<.1	.1
	Furnace Creek	23	.1	<.1	.1
	Lone Pine	26	.1	<.1	.1
	Needles	19	.1	<.1	.1
	Ridgecrest	31	.1	<.1	.1
	Shoshone	31	<.1	<.1	.1
Nev:	Alamo	31	<.1	<.1	.1
	Austin	24	<.1	<.1	.1
	Beatty	30	.1	<.1	.1
	Blue Eagle Ranch (Currant)	31	<.2	<.1	.1
	Blue Jay	31	<.1	<.1	.1
	Caliente	31	<.1	<.1	.1
	Currant Ranch	31	<.2	<.1	.1
	Diablo	30	<.1	<.1	.1
	Duckwater	29	<.1	<.1	.1
	Ely	31	<.1	<.1	.1
	Eureka	31	.1	<.1	.1
	Fallini's Springs Ranch	31	.1	<.1	.1
	Geyser Maintenance Station	30	<.1	<.1	.1
	Goldfield	30	<.1	<.1	.1
	Groom Lake	20	.1	<.1	.1
	Hiko	31	.1	<.1	.1
	Indian Springs	31	.1	<.1	.1
	Las Vegas	20	.1	<.1	.1
	Lathrop Wells	31	<.1	<.1	.1
	Lida	31	<.1	<.1	.1
	Lund	28	<.1	<.1	.1
	Mesquite	31	.1	<.1	.1
	Nyala	31	.2	<.1	.1
	Pahrump	29	.1	<.1	.1
	Pioche	31	<.1	<.1	.1
	Round Mountain	31	<.1	<.1	.1
	Scotty's Junction	26	<.1	<.1	.1
	Stone Cabin Ranch	31	<.1	<.1	.1
	Sunnyside	8	<.1	<.1	.1
	Tonopah	31	<.1	<.1	.1
	Tonopah Test Range	26	<.1	<.1	.1
	Warm Springs	28	<.1	<.1	.1
	Warm Springs Ranch	31	.1	<.1	.1
Utah:	Cedar City	30	<.1	<.1	.1
	Delta	31	<.2	<.1	.1
	Garrison	31	<.1	<.1	.1
	Milford	31	<.1	<.1	.1
	St. George	31	.1	<.1	.1

* Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reportable value of 0.1 pCi/m³ is reported as <0.1.

Results

Table 1 presents the monthly average gross beta concentrations in air for each of the network stations. The highest gross beta concentration within the network was 0.2 pCi/m³ at Baker, Calif. and Nyala, Nev. The minimum reporting concentration for gross beta is 0.1 pCi/m³. For averaging purposes, individual concentrations which are below the minimum detectable concentration (0.06 pCi/m³) are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reporting level (0.1 pCi/m³) are reported as <0.1 pCi/m³. No radionuclides were identified by gamma spectrometry on any filters or charcoal cartridges during January.

Complete copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC-LV upon written request.

Surface Air Sampling Program–80th Meridian Network[1] January-December 1970

Health and Safety Laboratory
Atomic Energy Commission

The Health and Safety Laboratory (HASL), began its Surface Air Sampling Program in January 1963, as a continuation of the 80th Meridian Program conducted by the U.S. Naval Research Laboratory. The objective of this program is to study the spatial and temporal distribution of nuclear weapons debris and lead in the surface air.

The basic network consists of a line of sites approximately along the 80th meridian extending from about 81° N. to 90° S. latitudes (figure 1). Since 1963, a number of sites have been added to investigate the possible effects of longitude, elevation, and proximity to coastlines; and from late 1965 through March 1969, samplers were placed on four Atlantic Ocean weather ships to extend the surface air study over the marine environment.

Sampling and analytical procedures

Approximately 1,400 cubic meters of ambient air per day are drawn through an 8-inch diameter microsorban filter for the land stations. For the ocean stations, about 2,200 cubic meters of air per day were filtered by an 8- by 10-inch microsorban filter. Each filter is changed on the 1st, 8th, 15th, and 22nd of the month or more frequently if the filter becomes clogged with debris suspended in the air.

The filters are returned to HASL at the end of each month and under normal conditions, composited into monthly samples for analysis. Until late 1969, the composited sample was first gamma counted and then sent to a contractor laboratory for radiochemical analysis. In the current program, each sample is split into equal aliquots, one for gamma counting and spectrometry and the other for radiochemistry and stable lead analysis. Hence, half of each sample is now being kept and stored for possible future work.

Daily pump pressure drop and temperature readings are also submitted to HASL along with the samples for the purpose of computing the volume of sampled air.

Gamma analysis

The gamma activity of half of the monthly composites are obtained with a 8- by 4-inch sodium iodide (Tl) crystal as soon as possible after receipt of the samples. The integrated response between 100 keV and 3.0 MeV is corrected by the average detection efficiency (35 percent) of the gamma photons present in fallout; and the total gamma activities are reported in units of photons per minute per 1,000 standard cubic meters.

Gamma spectra of the monthly composites are obtained using a lithium-drifted germanium diode (GeLi) system. Concentrations of the gamma emitting nuclides, beryllium-7, zirconium-95, cesium-137, and cerium-144 are determined by computer resolution of the spectra. Beginning in June 1970, all results from these nuclides, reported in the tables were obtained using this system.

Radiochemical analyses

The other halves of the monthly composites are sent to a contractor laboratory for radiochemical analyses.

There were no major weapon test series from the end of 1962 until May 1966. Consequently, only the longer-lived artificially produced radionuclides were present in the filters collected during this period, and emphasis was given to the determination of manganese-54, iron-55, strontium-90, cadmium-109, cesium-137, ce-

[1] Summarized from "Fallout Program Quarterly Summary Report," HASL–268 (January 1, 1973) available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

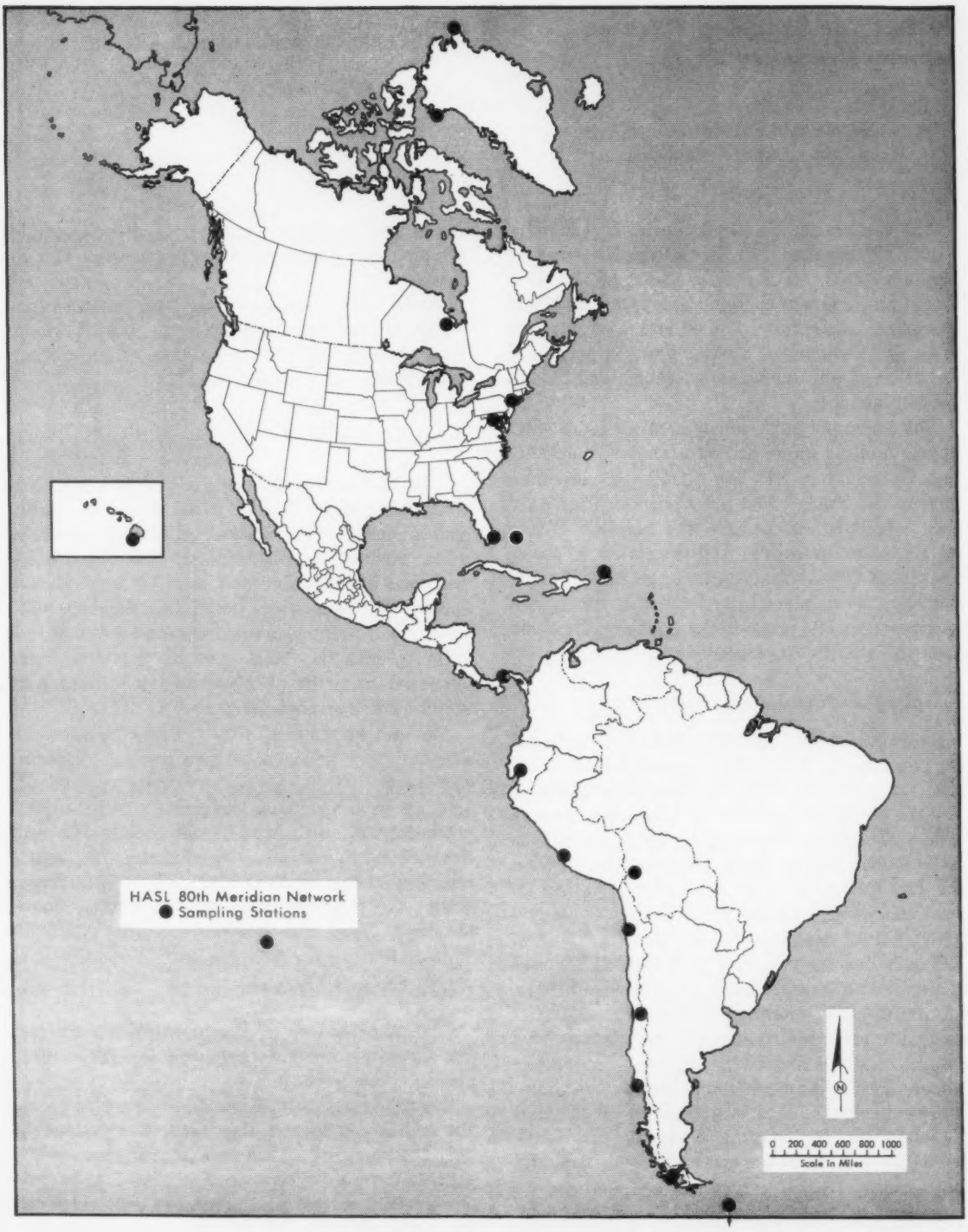

Figure 1. HASL 80th Meridian Network sampling stations

Table 1. Station location

Site		Latitude	Longitude (west)	Elevation (meters)
Greenland:	Nord	81° 40′N	17° 00′	250
	Thule	76° 36′N	68° 35′	259
Ontario:	Moosonee	51° 16′N	80° 30′	10
N.Y:	New York City	40° 48′N	73° 58′	38
Va:	Sterling	38° 58′N	77° 25′	76
Fla:	Miami	25° 49′N	80° 17′	4
Bahamas:	Bimini	25° 46′N	79° 22′	3
Hawaii:	Mauna Loa	19° 28′N	155° 36′	3,401
P.R:	San Juan	18° 26′N	66° 00′	10
Panama:	Balboa	8° 58′N	79° 34	23
Ecuador:	Guayaquil	2° 10′S	79° 52′	7
Peru:	Lima	12° 01′S	77° 08′	13
Bolivia:	Chacaltaya	16° 21′S	68° 07′	5,220
Chile:	Antofagasta	23° 37′S	70° 16′	31
	Isle de Pasqua	27° 10′S	109° 26′	41
	Santiago	33° 27′S	70° 42′	520
	Puerto Montt	41° 27′S	72° 57′	7
	Punta Arenas	53° 08′S	70° 53′	35
Antarctica [a]		62° 56′S	60° 36′	16
		64° 49′S	62° 52′	10
South Pole station		90° 00′S	----------	2,800

[a] The Chilean Antarctic station has moved at least three times within an area of about 2° latitude and longitude. For simplicity, the individual station names were dropped and all data grouped under "Antarctica."

rium-144, plutonium-238, and plutonium-239. In samples collected after French or Chinese atmospheric weapons tests, additional short-lived nuclides were analyzed, such as strontium-89, zirconium-95, and cerium-141.

The longer-lived fission products and plutonium-239 concentrations should describe the general distribution in surface air in all previous nuclear weapon debris which was transferred from the lower stratosphere to the troposphere during the collection period of this report. Other tracer nuclides can be associated with debris from a single detonation or series of detonations. Manganese-54 and iron-55 were produced in large quantities in the 1961 and 1962 test series. Cadmium-109 was generated by the U.S. high altitude test over Johnston Island on July 9, 1962. While plutonium-238 is present in low concentrations in nuclear weapons debris, about 17,000 curies of plutonium-238 was disseminated at high altitude in the stratosphere on April 21, 1964 during the reentry burnup of a SNAP-9A power source.

As the levels of any of the radionuclides drop to below practical detection limits they are eliminated from the radiochemical program; thus cadmium-109 was not analyzed after the end of 1967.

In response to the growing concern over air pollution and in particular to the known hazard linked to stable lead, analysis for this element was added to the program.

Most of the analyses of surface air samples were carried out from July 1969 to the present by the Trapelo Division, Richmond, Calif.[2]

[2] Trapelo Division West is now LFE-Environmental Analysis Laboratories.

Table 2. Strontium-89 concentrations in air, 1970[a]

Site		Concentration (fCi/m³)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland:	Nord	---	---	---	---	---	---	---	---	1.40	260	24.5	---
	Thule	2.45	3.91	3.64	11.6	7.43	1.94	---	3.90	2.32	186	1.90	---
Ontario:	Moosonee	[b] 1.86	2.94	---	8.02	14.1	14.1	---	6.70	2.31	1.83	1.85	1.98
N.Y:	New York City	2.78	4.35	9.48	13.5	20.2	11.9	14.5	8.54	3.00	2.51	4.54	4.94
Va:	Sterling	1.69	4.68	7.06	17.9	24.3	22.0	11.7	7.66	2.66	2.09	5.02	5.49
Fla:	Miami	5.40	10.9	17.7	50.2	56.5	4.05	6.61	4.15	2.42	3.62	6.29	5.65
Bahamas:	Bimini	---	16.8	20.5	36.0	35.7	---	11.7	7.88	2.90	4.83	9.64	6.31
Hawaii:	Mauna Loa	10.4	27.7	54.2	54.4	35.1	19.7	18.0	6.21	7.15	12.5	6.89	3.72
P.R:	San Juan	2.51	17.1	8.17	28.6	17.5	13.2	9.03	7.03	3.43	4.27	5.67	3.60
Panama:	Balboa	5.25	5.45	---	15.9	10.7	6.88	4.39	---	4.53	---	---	---
Ecuador:	Guayaquil	---	---	[b] .42	---	[b] .18	17.5	52.5	28.0	25.7	10.1	6.9	4.66
Peru:	Lima	---	---	---	[b] .58	[b] .51	[b] .22	---	---	78.6	64.3	51.9	15.4
Bolivia:	Chacaltaya	---	---	---	(c)	32.2	---	---	---	214	114	63.1	11.8
Chile:	Antofagasta	---	---	---	---	---	---	---	128	83.4	53.1	36.5	22.1
	Santiago	---	---	[b] 1.08	[b] .28	39.9	10.0	61.3	---	54.4	34.0	6.5	23.3
	Puerto Montt	---	---	---	---	---	4.94	11.7	18.4	16.6	11.7	14.2	7.93
	Punta Arenas	---	---	[b] .50	[b] .22	[b] .19	1.34	4.57	4.60	6.38	4.82	6.45	3.23
Antarctica		---	---	---	---	---	---	---	(c)	(c)	(c)	[b] .42	(c)
South Pole station		---	---	---	---	(c)	[b] 3.27	[b] 5.92	4.62	7.72	8.56	5.48	15.1

[a] Errors are less than 20 percent except:
[b] Error between 20–100 percent;
[c] Error greater than 100 percent.
—, no data reported.

Table 3. Strontium-90 concentrations in air, 1970[a]

Site		Concentration (fCi/m³)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland:	Nord									1.36	1.18	1.18	
	Thule	1.42	1.60	4.68	3.09	2.51	.72		1.85	2.14	1.10	.87	
Ontario:	Moosonee	1.01	1.26		2.39	4.32	3.85	4.29	4.17	2.40	1.69	1.04	1.12
N.Y:	New York City	1.15	1.91	2.77	3.37	5.80	3.81	5.50	5.23	2.24	1.63	1.59	.99
Va:	Sterling	.98	1.88	2.05	3.35	5.92	6.25	4.78	5.16	2.17	1.40	1.38	.90
Fla:	Miami	1.47	3.03	2.71	7.95	11.20	4.11	2.58	1.97	.98	1.14	1.51	1.96
Bahamas:	Bimini	1.72	3.42	4.31	6.77	8.43		4.28	3.27	.86	.89	1.90	2.39
Hawaii:	Mauna Loa	1.43	3.68	7.00	7.48	7.39	5.15	4.42	2.05	2.37	.78	.95	.82
P.R:	San Juan	.60	1.37	2.69	5.55	3.63	3.42	3.89	3.45	1.17	.54	.91	1.18
Panama:	Balboa	.73	1.05		2.35	2.43	.58	.81		.21			
Ecuador:	Guayaquil	.51	[b] .70	.28		.18	.38	.49	.45	.75	.46	.40	.42
Peru:	Lima	3.45	1.89	1.66	1.95	.89	1.02			2.42	3.25	3.14	1.36
Bolivia:	Chacaltaya	.72	.61	.31	.54	1.69				3.86	3.68	3.50	.82
Chile:	Antofagasta	4.99	1.42	1.15					2.12	2.74	2.87	2.27	2.03
	Isle de Pasqua						.75						
	Santiago	2.46	[c]	1.73	1.20	.81	1.19	1.34		1.88	1.85	.44	2.40
	Puerto Montt						.46	.50	.63	.80	.77	1.18	.88
	Punta Arenas	.70	1.16	.60	.64	.39	.20	.39	.30	.37	.39	.51	.41
Antarctica		1.18	2.03	.89	1.20	1.12	.64	.75	.34	.50	.63	.57	.48
South Pole station						.44	.81	.85	.54	.69	.78	.62	1.79

[a]Errors are less than 20 percent except:
[b]Error between 20–100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Table 4. Zirconium-95 concentrations in air, 1970[a]

Site		Concentration (fCi/m³)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland:	Nord									7.59	5.53	[b] 4.29	[b] 6.40
	Thule	6.36	8.99	19.0	24.2	21.9	7.05	22.10	6.10		[b] .01	3.11	
Ontario:	Moosonee	4.23	5.94	19.5		48.6	14.9	63.8	27.7	13.2	7.73	[c]	3.89
N.Y:	New York City	6.19	11.3	24.2	39.3	62.2	76.5	56.7	46.4	15.9	7.75	10.1	4.43
Va:	Sterling	5.01	10.8	18.2		70.1	86.4	55.4	38.3	13.9	9.25	11.8	[b] 2.98
Fla:	Miami	12.0	29.1	40.3	91.9	105	50.3	40.7	23.8	7.5	12.7	17.3	14.3
Bahamas:	Bimini	16.0	57.5	85.6	94.5	129	65.9	53.6	28.3	10.6	16.1	23.9	[b] 13.0
Hawaii:	Mauna Loa	20.1	67.6	141		122	89.2	57.5	20.9	19.5	21.4	10.8	10.4
P.R:	San Juan	6.46	25.9	19.6		80.9	37.9	48.4	27.1	11.7	9.87	9.31	7.12
Panama:	Balboa	10.1	11.9			28.0	19.1	14.3	19.9	9.42			
Ecuador:	Guayaquil	[c]	1.44			1.01	32.3	122	79.8	77.8	36.9	39.8	34.4
Peru:	Lima	4.66	1.44		[b] 1.19	[b] 1.23	85.5	897	361	244	215	117	84.3
Bolivia:	Chacaltaya	2.60	.92	.61		45.0	735	415	813	392	220	110	
Chile:	Antofagasta	4.94	[b] 1.05	.85				525	350	211	170	69.7	55.8
	Isle de Pasqua						[b]380						
	Santiago	[b] 2.01	2.38	[b] 1.14	[c]	71.8	16.2	139	107	130	138	70.7	61.9
	Puerto Montt						9.35	25.4	29.7		27.6	4.44	17.3
	Punta Arenas	[b] 1.32	.99	[b] .32		[c]	3.08	9.31	9.65		13.0	14.9	8.63
Antarctica											[b]109	[b] 98.7	
South Pole station								[b] .00		14.8	18.4	12.2	13.1

[a]Errors are less than 20 percent except:
[b]Error between 20–100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Results

The radioactivity concentrations in surface air during January–December 1970 are presented in tables 2 through 8. The sites are listed according to latitude beginning with the most northern site at Nord, Greenland (table 1).

The concentrations are reported at the midpoint of the collection month for the plutonium isotopes and the fission products.

One standard deviation of the counting error for these data is always less than ±20 percent unless otherwise indicated.

Table 5. Cesium-137 concentrations in air, 1970[a]

Site		Concentration (fCi/m³)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland:	Nord									2.66	8.42	2.81	4.29
	Thule	2.31	2.58	3.91	4.62	4.04	1.28	4.24	3.50		5.28	1.51	
Ontario:	Moosonee	1.46	2.24	4.22		8.40	6.13	12.0	7.49	4.56	2.97	1.91	2.33
N.Y:	New York City	1.98	2.84	4.46	5.16	8.15	11.9	10.7	11.8	5.33	3.18	2.48	1.74
Va:	Sterling	.80	2.87	3.13		9.36	12.1	10.3	9.45	4.40	3.11	2.34	2.05
Fla:	Miami	2.00	4.83	5.05	9.73	11.4	8.34	7.39	5.60	1.97	2.78	3.43	4.84
Bahamas:	Bimini	3.17	8.73	7.10	12.2	14.6	9.76	9.68	6.44	2.49	3.14	3.92	5.07
Hawaii:	Mauna Loa	2.24	6.78	11.1		13.8	11.5	9.16	4.03	4.66	1.15	1.40	1.92
P.R:	San Juan	.87	3.56	4.37		8.94	5.57	8.99	6.68	2.61	1.13	1.45	2.01
Panama:	Balboa	.85	1.66			3.64	1.43	1.90	1.37	[b] .40			
Ecuador:	Guayaquil	.92	.95	.64		.33	.78	1.87	.91	1.89	1.37	1.70	2.08
Peru:	Lima	4.72	2.63	2.46	3.18	1.34	2.17	11.8	5.20	6.15	8.53	5.90	5.02
Bolivia:	Chacaltaya	.84	.57	.49		2.54	7.38	5.68	7.82	6.31	6.03	4.30	
Chile:	Antofagasta	6.65	2.56	1.79				7.43	4.88	5.04	6.81	3.70	3.19
	Isle de Pasqua						1.21						
	Santiago	4.16	4.13	2.88	2.21	2.33	[b] .99	3.32	3.24	4.11	5.67	4.00	4.50
	Puerto Montt						.98	1.03	.98		1.22	3.43	1.38
	Punta Arenas	1.04	1.48	.94		.39	.44	.54	.58		.67	1.00	.75
Antarctica		3.65	1.48	1.32	1.39	1.22	1.72	.75	.46	.79	.81	.57	.70
South Pole station							1.28	[b] 1.95	.75	1.04	1.13	1.33	1.41

[a]Errors are less than 20 percent except:
[b]Error between 20–100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Table 6. Cerium-144 concentrations in air, 1970[a]

Site		Concentration (fCi/m³)											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland:	Nord									24.9	21.4	16.7	28.2
	Thule	19.7	21.3	38.6	45.1	47.7	12.7	46.6	39.2		14.9	12.7	
Ontario:	Moosonee	14.2	19.5	39.2		77.3	99.3	123	71.7	41.8	22.8		
N.Y:	New York City	18.9	28.6	38.1	57.4	105	132	115	117	47.0	29.2	22.0	14.6
Va:	Sterling	13.7	25.9	29.9		94.2	148	108	96.4	43.1	29.4	20.0	14.0
Fla:	Miami	23.4	49.2	56.5	144	165	80.0	82.8	54.6	18.5	25.9	26.5	34.9
Bahamas:	Bimini	33.2	90.4	85.6	135	203	107	102	68.7	21.9	28.8	37.7	37.3
Hawaii	Mauna Loa	25.2	75.8	109		157	133	98.4	38.7	43.1	10.4	13.7	14.6
P.R:	San Juan	9.67	37.6	48.0		106	62.1	97.3	62.6	20.9	10.6	11.1	15.1
Panama:	Balboa	12.3	16.1			39.4	19.1	20.1	13.5	3.81			
Ecuador:	Guayaquil	7.76	7.98	5.16		3.12	3.19	28.2	20.6	25.3	17.2	18.0	26.6
Peru:	Lima	36.3	20.4	18.0	15.8	6.57	23.2	189	88.3	82.1	103	67.0	63.4
Bolivia:	Chacaltaya	6.27	5.75	3.23		17.8	152	108	176	108	90.4	57.2	
Chile:	Antofagasta	46.7	12.5	14.5				126	90.1	76.2	84.7	43.8	39.8
	Isle de Pasqua						11.7						
	Santiago	27.8	38.9	20.6	12.2	20.9	6.37	38.3	36.3	41.7	70.2	45.6	51.1
	Puerto Montt						5.70	8.32	10.3		14.6	20.5	15.1
	Punta Arenas	7.13	10.1	6.58		2.33	1.08	4.44	4.52		4.26	10.0	.87
Antarctica		[b] 3.96		[b] 8.24	[b] 5.23	2.59	1.16	2.22	[b] 1.94	[b] 7.12	3.97	4.23	5.68
South Pole station							6.09	[b] 8.97	4.50	8.09	9.54	9.21	12.1

[a]Errors are less than 20 percent except:
[b]Error between 20-100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Table 7. Plutonium-238 concentrations in air, 1970[a]

Site	Concentration (aCi/m³)											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland: Nord									[b] 2.64	[b] 0.99	[b] 2.29	
Thule	[b] 5.17	5.50	7.53	[b] 9.17	8.63	[b] 0.92	[b] 4.58	[b] 3.65	[b] 3.49	[b] 2.46	[b] 2.35	
Ontario: Moosonee	[b] 4.64	6.64	11.2	[b] 12.7	9.73	9.44	9.05	[b] 4.55	[b] 4.05	[b] 1.69	[b] 3.47	[b] 0.97
N.Y: New York City	4.73	10.5	9.08	12.5	12.8	11.7	9.51	10.9	12.2	6.82	4.72	
Va: Sterling	[b] 3.86	8.32	9.11	10.1	11.4	10.3	7.34	12.0	[b] 2.42	[b] 3.17	7.76	[b] 2.39
Fla: Miami	[b] 7.54	13.8	9.33	15.9	15.7	9.94	[b] 4.78	[b] 4.32	[b] 1.37	[b] 3.60	[b] 2.68	[b] 3.45
Bahamas: Bimini	[b] 5.42	19.8	[b] 10.6	21.9	22.1		6.66	[b] 6.41	[b] 2.45	[b] 1.86	[b] 5.57	[b] 8.58
Hawaii: Mauna Loa	[b] 5.67	11.0	21.1	[b] 11.9	12.5	[b] 7.92	[b] 6.85	[c]	[b] 3.43	[b] 3.68	31.9	[b] 3.56
P.R: San Juan	[b] 2.90	11.3	8.67	[b] 12.6	11.0	[b] 5.54	[b] 6.43	[b] 7.92	[b] 1.73	[b] 1.32	[b] 2.05	[b] 5.64
Panama: Balboa	[b] 6.08	[b] 5.64		8.52	[b] 7.98	[b] 1.61	[c]		[b] 4.07			
Ecuador: Guayaquil	7.26	[b] 6.82	[b] 5.09		[c]	[b] 2.22	30.2	[b] 4.85	15.0	5.84	6.49	9.33
Peru Lima	24.0	16.0	17.8	[b] 14.4	[b] 5.96	10.3			44.6	34.5	20.9	14.6
Bolivia: Chacaltaya	[b] 5.56	[b] 3.83	[b] 2.75	[c]	19.5				36.9	17.5	14.0	[b] 2.84
Chile: Antofagasta	[b] 22.2	[b] 10.4	12.8					24.2	47.2	32.9	13.2	[b] 8.00
Isle de Pasqua						6.53						
Santiago	[b] 76.3	24.6	20.2	104	11.1	31.4	18.9		23.4	22.2	10.6	15.2
Puerto Montt						[b] 5.24	[b] 3.61	[b] 4.88	9.11	8.18	[c]	6.75
Punta Arenas	[b] 5.65	[b] 26.2	[c]	6.45	[b] 2.79		[b] 3.20	[b] 2.45	[b] 3.52	[b] 2.79	[b] 3.03	[b] 2.55
Antarctica	[b] 6.76	[b] 2.77	[b] 1.08	[b] 1.37	[c]	[c]	[b] 1.41	[c]	[b] .99	[b] 3.15	[c]	[c]
South Pole station					[b] 3.94	9.27	[b] 12.9	[b] 4.21	5.99	9.79	[b] 4.05	4.81

[a]Errors are less than 20 percent except:
[b]Error between 20–100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Table 8. Plutonium-239 concentrations in air, 1970[a]

Site	Concentration (aCi/m³)											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Greenland: Nord									22.7	23.0	19.9	
Thule	36.0	31.4	56.0	61.3	54.0	14.3	40.7	33.6	34.9	19.2	14.5	
Ontario: Moosonee	22.2	26.9	59.2	51.9	74.7	94.4	112	72.3	49.9	31.1	17.4	21.0
N.Y: New York City	28.2	44.8	48.3	65.2	99.9	125	118	111	51.8	36.0	26.2	
Va: Sterling	18.0	36.4	41.9	60.0	104	113	88.4	90.1	44.6	25.5	23.9	13.2
Fla: Miami	28.2	65.7	63.0	119	147	80.3	65.6	46.9	19.5	39.0	34.3	43.7
Bahamas: Bimini	45.8	123	81.7	139	185		83.2	66.9	26.1	32.7	46.3	53.6
Hawaii: Mauna Loa	25.8	76.6	140	133	126	115	83.3	36.9	47.0	[b] 9.05	15.4	13.7
P.R: San Juan	14.7	47.8	52.3	120	69.3	63.4	115	71.6	32.0	15.0	14.9	19.8
Panama: Balboa	14.7	22.3		48.8	48.1	15.8	[b] 18.9		[b] 4.67			
Ecuador Guayaquil	6.28	10.3	[b] 9.49		[c]	17.8	200	24.3	30.6	17.5	23.4	30.2
Peru: Lima	48.7	29.6	54.1	[b] 27.6	7.41	67.1			122	94.0	69.1	72.8
Bolivia: Chacaltaya	[b] 6.67	[b] 11.5	5.79	[c]	97.7				106	71.7	54.8	[b] 14.8
Chile: Antofagasta	50.9	26.5	23.0					83.4	126	99.2	44.3	42.0
Isle de Pasqua						19.7						
Santiago	[b] 51.0	87.3	23.0	[b] 23.7	100	236	82.8		59.5	59.7	42.1	47.7
Puerto Montt						11.3	13.9	15.0	21.4	18.3	[b] 27.2	18.4
Punta Arenas	[b] 12.7	[b] 17.5	[b] 9.54	10.4	4.34	4.49	10.5	7.18	9.28	8.7	11.7	[b] 3.68
Antarctica	15.5	32.0	14.7	18.8	15.90	13.9	9.21	[b] 8.56	6.08	[b] 6.85	9.6	9.08
South Pole station					[b] 6.39	12.9	[b] 9.11	10.3	11.5	16.2	10.3	16.2

[a]Errors are less than 20 percent except:
[b]Error between 20–100 percent;
[c]Error greater than 100 percent.
—, no data reported.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
January–December 1969	February 1972

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site, January-June 1970[1]

National Environmental Research Center-Las Vegas,[2] and Nevada Operations Office, AEC

Under a Memorandum of Understanding with the U.S. Atomic Energy Commission, the National Environmental Research Center-Las Vegas (NERC-LV), conducted its continuing program of radiological surveillance for the Nevada Test Site (NTS) and other areas designated by the AEC from January through June 1970. During this period, 24 announced underground nuclear tests were conducted at the NTS. Offsite radiological surveillance was also provided for the post-event ventilation of the entry tunnel for the "Mint Leaf Event" at the NTS and for "Humid Water," a nonnuclear event conducted near Hattiesburg, Miss.

[1] This article is a summary of report No. SWRHL-108r, "Off-Site Surveillance Activities of the Southwestern Radiological Health Laboratory from January through June 1970."

[2] Formerly Southwestern Radiological Health Laboratory, U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health.

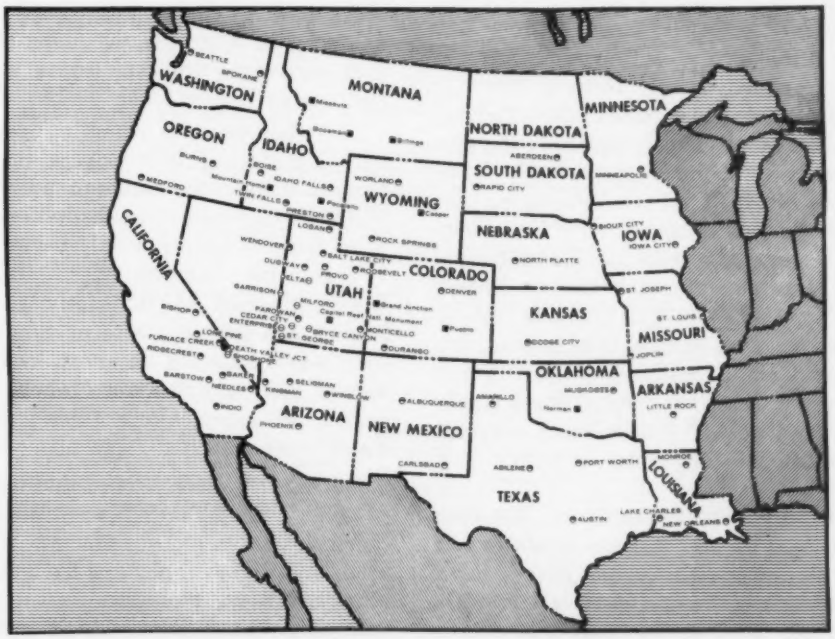

Figure 1. Air sampling and gamma-rate recorder network stations outside Nevada

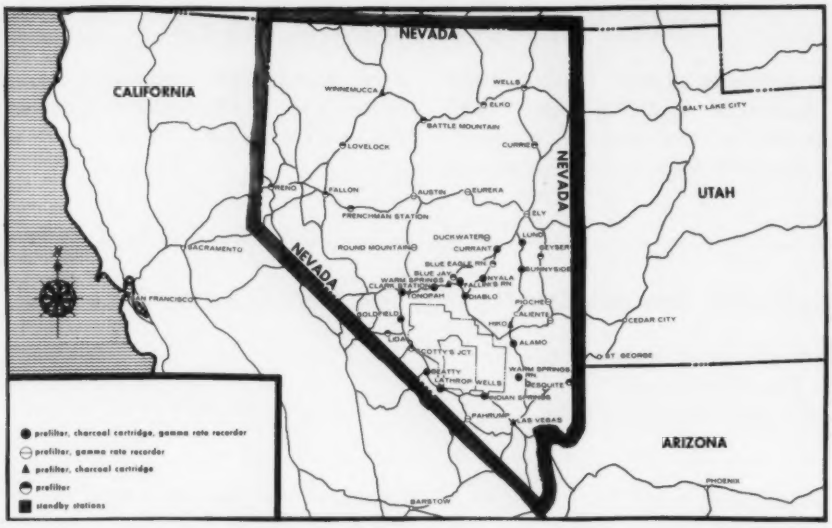

Figure 2. Air sampling and gamma-rate network stations in Nevada

Operational procedures

Before each event, mobile ground monitors were positioned downwind. If a release occurred, they conducted a monitoring program directed from a control point located on the NTS. In addition to the routine sampling and monitoring provided within about a 300-mile radius of the NTS, surveillance was extended as necessary to provide adequate coverage. Measurements were made periodically until activity levels returned to background.

Each monitor was equipped with two Eberline E–500B survey meters, a Baird-Atomic NE–148A Scintillator and a Victoreen Radector, Model No. AGB–50B–SR. Eberline RM–11 gamma-rate recorders at fixed locations (figure 1) documented cloud passage. An Air Force U–3A aircraft was used for aerial cloud tracking and two NERC-LV Turbo-Beech aircraft provided additional long-range tracking and sampling.

The NERC-LV Air Surveillance Network (ASN) consisted of 102 stations operating in every State west of the Mississippi River except Montana and North Dakota (figures 1 and 2). The air sampler used in the ASN was a Gelman "Tempest" which consisted of a Gast Model 1550 vacuum pump driven by an electric motor. For filter media, a 4-inch-diameter Gelman type E glass-fiber filter was used at each sampling station; and at 20 stations close to the NTS, an MSA charcoal cartridge was also used behind each filter. By telephone request, charcoal cartridges were added to other selected stations as requested.

The routine milk sampling program from both commercial and private producers continued. During the 6-month period, 209 samples were collected from about 45 sources which were sampled on a monthly basis.

Vegetation samples were collected after known releases of radioactivity to help delineate the fallout pattern. Samples of cow feed were collected at most locations where special milk samples were taken. During this period, 566 samples of potable and nonpotable water were collected from about 98 locations.

During the latter part of this period, the use of film badges was discontinued and only thermoluminescent dosimeters (TLD) were used for both personnel and fixed station dosimetry. Sixty-two residents in the offsite area wore TLD's and three TLD's were placed at each of the 102 permanent stations.

A NERC-LV medical officer was available to investigate reports of injuries alleged to be a result of the test series and to maintain liaison with local physicians. No injuries were reported. Veterinarian services were also provided to conduct wildlife and domestic livestock investigations. Community information centers were established in towns around the NTS for one event involving a device in the megaton range, to disseminate information on the event schedule and possible hazards. A number of offsite residents participated in the sampling program. All routine air sampling stations except those in Las Vegas were operated by local residents.

Analytical procedures

Samples were returned to the NERC-LV for radiological analysis. Air sample particulate filters were counted for beta radioactivity in a Beckman Widebeta, low-background proportional counter system. Selected particulate filters, all charcoal cartridges, and water and milk samples were analyzed for gamma-emitting radionuclides using a 4- by 4-inch NaI(Tl) crystal coupled to a TMC Model 404C gamma pulse height analyzer. The lower limit of detection for gamma emitters in air, milk, and water samples was 10 pCi/m^3, 20 pCi/liter, and 20 pCi/liter, respectively, at the time of count. Gamma spectra were evaluated using a matrix technique which allowed for the simultaneous determination of eight nuclides.

Results

Radioactive material was released offsite following one underground nuclear test the "Snubber Event," on April 21, 1970.

The highest level of radioactivity attributed to the "Snubber Event" was about 0.6 mR/h above background measured at Coyote Summit, an unpopulated location. The net gamma exposure from the integration of readings with time at this location was 0.15 mR. No exposure levels above normal background were detected by TLD's. Special samples of vegetation, soil, snow, drinking water, cow feed and milk were collected after this event, including 40 milk samples from eight standby milk stations in Utah and 34 from seven standby milk stations in Arizona. Event-related radioactivity was found only on snow samples collected at two locations and on air samples obtained at nine locations. A snow sample collected at Sunnyside on the day following the event contained 500 pCi/liter of iodine-133, and 690 pCi/liter of iodine-135. The analytical results for air samples with activity above background levels are shown in table 1.

Table 1. Five highest iodine-133 and iodine-135 results and associated gross beta results from air sample media extrapolated to end of collection period (combined particulate and charcoal filters) Snubber Event, April 21, 1970

Location azimuth-distance from CP-1	Time on off	Date on off (1970)	Average concentrations during collection period and integrated concentrations					
			Gross beta		Iodine-133		Iodine-135	
			pCi/m^3	μCi-s/m^3	pCi/m^3	μCi-s/m^3	pCi/m^3	μCi-s/m^3
Coyote Summit, Nev.,[a] 25°, 49 miles	0835 1440	4/21 4/21	6.0	0.13	87	1.9	300	6.6
Coyote Summit, Nev., Koyne's Mills, 23°, 52 miles	0833 1440	4/21 4/21	<2.7	<.06	36	.79	86	1.9
Currant Maintenance Station, Nev., 16° 135 miles	0655 0745	4/21 4/21	.5	.05	5.6	.51	ND	ND
Hancock Summit, Nev.,[a] 48°, 49 miles	0825 1449	4/21 4/21	<2.5	<.06	12	.28	4.5	.10
Nyala, Nev., 11°, 91 miles	0800 0800	4/21 4/22	<.2	<.02	3.3	.28	ND	ND

[a] Temporary stations.
ND, nondetectable.

A controlled release of radioactivity was conducted on the day following the "Mint Leaf Event" of May 5. The entry tunnel was ventilated on May 6, 1970, to enable workers to reenter the area. A portable air sampler operating at the Valley Road-Highway 25 junction (near Koyne's Mill) indicated a concentration of 700 pCi/m^3 of xenon-135, assuming 100-percent collection efficiency for xenon on a charcoal cartridge. Although it is known that the collection efficiency of activated charcoal for xenon is less than 100 percent, uncertainties regarding the efficiency of this specific sampler under the conditions it was operating preclude providing a more exact concentration value. This was the only indication of activity measured offsite.

Conclusions

Environmental radiation surveillance during this period indicated that no individual in the offsite area received an exposure resulting from nuclear testing activities in Nevada which exceeded the guides established by the AEC and/or the Federal Radiation Council. No measurable whole body exposures were observed and environmental sampling data indicated that the maximum hypothetical radiation dose to an infant thyroid (2 grams) was less than 1 mrem as a result of inhalation, with no contribution from ingestion.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of the environmental radio activity data follow for Argonne National Laboratory.

[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

1. Argonne National Laboratory[2] January–December 1971

University of Chicago
Lemont, Ill.

Argonne National Laboratory (Illinois site) is located on a 3,700-acre site in DuPage County, 27 miles southwest of downtown Chicago. It lies south of Interstate Highway 55 and west of Illinois Highway 83. The terrain is rolling, partially-wooded, former prairie and farmland. The grounds contain a number of ponds and small streams, the principal one being Sawmill Creek, which runs through the site in a southerly direction and enters the Des Plaines River about 1.3 miles southeast of the center of the site. The land is drained primarily by Sawmill Creek, although the extreme southern portion drains directly into the Des Plaines River. This river flows southwest until it joins the Kankakee River about 30 miles southwest of the laboratory to form the Illinois River.

Argonne is a multidisciplinary research and development laboratory with two principal objectives: it carries out a broad program of basic research activities, and it serves as an important center for the design and development of nuclear reactors. Most of the basic research is concerned with the application of radiation as a tool in the physical and life sciences. The reactor effort is now devoted largely to development of the liquid-metal-cooled fast-breeder power reactor. Almost all of the work at the laboratory is of an unclassified nature and deals with peacetime applications of nuclear energy.

The principal nuclear facilities at the laboratory are a 5 MW heavy-water cooled and moderated general-purpose research reactor (CP–5) fueled with fully-enriched uranium; a 200 kW light-water cooled and moderated biological research reactor (JANUS) fueled with fully-enriched uranium; a 12.5 GeV proton accelerator, the Zero Gradient Synchrotron (ZGS); two critical assemblies, or zero power reactors (ZPR–6 and –9), that are fueled at various times with plutonium, uranium, or a combination of the two; a 60-inch cyclotron; several Van de Graaff accelerators; a fuel fabrication facility designed for plutonium usage; and several laboratories designed for work with irradiated fuel elements and with multicuries quantities of the heavy element alpha emitters.

The radioactivity of the environment was determined by measuring the concentrations of radioactive nuclides in naturally-occurring materials and by measuring the external penetrating radiation dose. Sample collections and measurements were made both on and off the site for comparison purposes. Since radioactivity is usually spread by air and water, the sample collection program has concentrated on these media. In addition, soil, plants, milk, precipitation, animals, and material from the beds of lakes and streams were also collected and analyzed. The results included in this report are those that are pertinent to the evaluation of Argonne's contribution to the environmental radioactivity and to the differentiation of Argonne activity from fallout and other sources.

When a nuclide was not detected, the result is given as less than ($<$) the minimum amount detectable (detection limit) by the analytical method used. Averages including individual results that were less than the detection limit were calculated by one of the following two methods. If the bulk of the individual results was less than the detection limit, the average was calculated with the assumption that such results were equal to the detection limit, and the resulting average value is expressed as less than the computed average. If only a small fraction of the individual results were less than the detection limit, the average was calculated with the assumption that such results were actually one-half of the detection limit, and the average is given as a positive value. The averages that are obtained by using these two methods under the conditions indicated are believed to give an adequate picture of the true average activity at locations where the activity not only varied greatly, but at times was not detectable.

Average values are usually accompanied by

[2] Summarized from "Environmental Monitoring at Major U.S. Atomic Energy Commission Contractor Sites—Calendar Year 1971."

a plus-or-minus (±) limit value. This value is the 95-percent confidence limit calculated from the standard deviation of the average and is a measure of the range in the activities encountered at that location. It does not represent the conventional error in the average of repeated measurements on the same or identical samples. Since many of the variations that occur in environmental radioactivity are not random but occur for specific reasons (e.g., nuclear testing), samples collected from the same location at different times are not replicates. The more random the variation in activity at a particular location, the closer the confidence limits will represent the actual distribution of values at that location. The averages and confidence limits should be interpreted with this in mind. When a ± figure accompanies an individual result in this report, it represents the statistical counting error at the 95-percent confidence level.

Where environmental quality standards have been established, the measured concentration or radiation dose is compared with the standard as a means of assessing its hazard. Unless otherwise specified, the standards used in this report are those given in AEC Manual Chapter 0524.

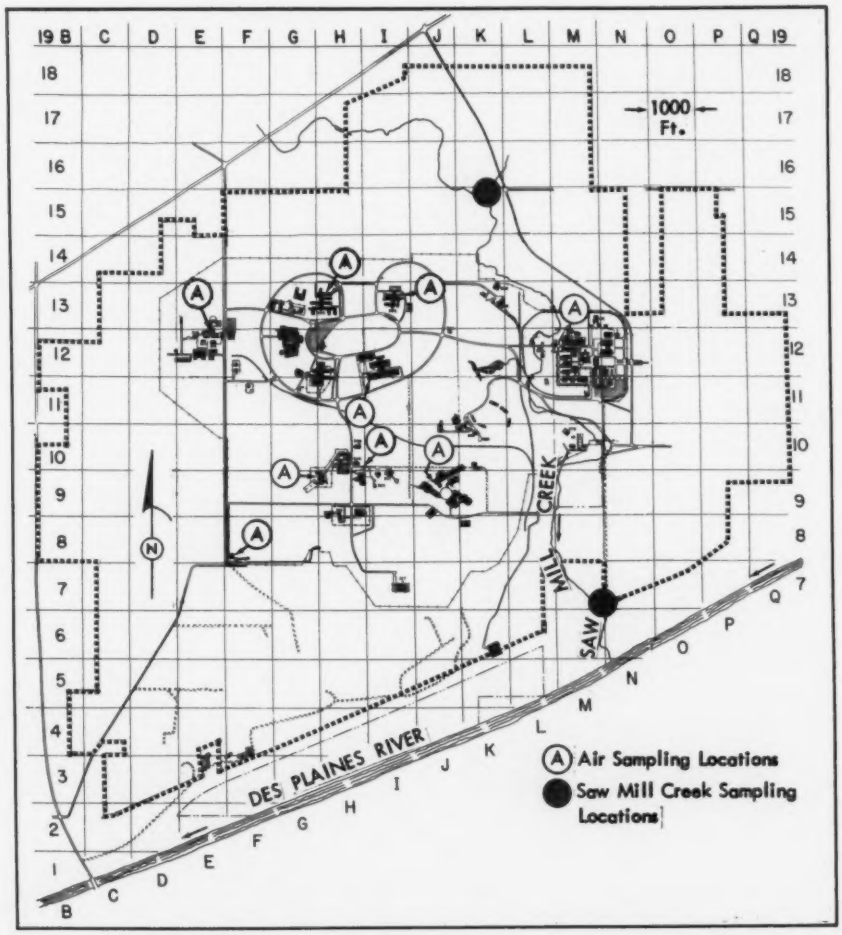

Figure 1. Onsite sampling locations at Argonne National Laboratory

Radioactivity in air

The radioactivity of particulate matter in air was determined by drawing air through filter paper at a known rate and measuring the radioactivity of the particles collected by the paper. Samples were collected continuously, except for occasional equipment failures, at nine locations on the Argonne site and at six locations off the site. The sampling locations are shown in figures 1 and 2. At one location on the site, the filter paper was changed daily, at all other locations, the filter papers were changed at weekly intervals. The daily samples record short-term changes in radioactivity, while the weekly samples are used to compare onsite and offsite activities. Higher activities on the site are indicative of radioactivity released by Argonne if the differences are greater than the error in sampling and counting. This error is between 5 and 20 percent for most results, but approaches 100 percent at the detection limit.

The total alpha and beta radioactivities in the weekly samples are given in table 1; the average concentrations of a number of gamma-ray emitters, as determined by gamma-ray spectrometry performed on composite weekly samples, are given in table 2. The alpha and beta radioactivities were measured in low-background gas-flow proportional counters, and the counting efficiencies used to convert counting rates to disintegration rates were those measured for radon decay products on filter paper. The gamma-ray measurements were

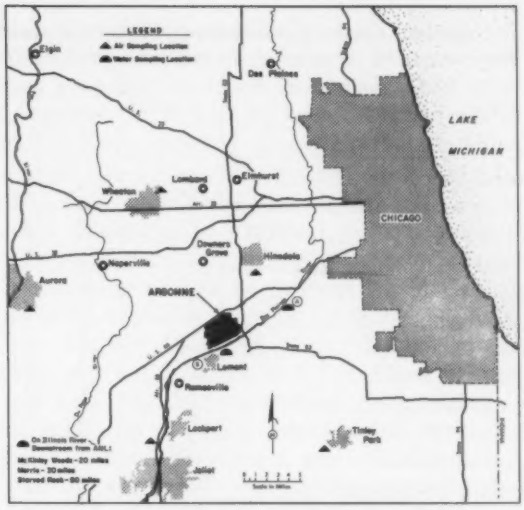

Figure 2. Locations of Argonne National Laboratory (including some offsite sampling locations)

Table 1. Alpha and beta radioactivity in air-filter samples,[a] Argonne National Laboratory January–December 1971

Period	Location	Number of samples	Alpha radioactivity (fCi/m³)			Beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average	Maximum	Minimum	Average
January	Onsite	26	5.1	2.2	3.4	0.14	0.068	0.097
	Offsite	28	4.9	1.8	3.3	.13	.070	.097
February	Onsite	26	3.7	.6	2.1	.16	.072	.12
	Offsite	24	4.3	1.3	2.5	.18	.072	.12
March	Onsite	31	5.4	.8	2.2	.38	.099	.20
	Offsite	26	4.7	1.2	2.2	.38	.12	.22
April	Onsite	30	9.0	1.8	4.9	.75	.14	.46
	Offsite	26	7.0	1.9	4.1	.76	.20	.47
May	Onsite	32	6.4	2.0	3.7	1.2	.45	.76
	Offsite	22	6.1	1.7	3.6	.98	.50	.77
June	Onsite	34	8.1	1.2	4.0	1.0	.42	.64
	Offsite	25	5.5	1.7	3.6	.80	.49	.64
July	Onsite	36	6.4	.8	3.3	.86	.36	.60
	Offsite	26	4.8	1.6	2.6	.88	.44	.69
August	Onsite	34	6.2	1.2	3.0	.54	.18	.32
	Offsite	23	6.7	1.2	3.3	.55	.21	.35
September	Onsite	35	5.7	1.3	2.9	.21	.072	.13
	Offsite	22	3.8	1.3	2.6	.23	.047	.14
October	Onsite	33	7.2	1.7	3.9	.14	.054	.098
	Offsite	19	5.2	1.9	3.2	.16	.070	.10
November	Onsite	33	5.5	1.0	2.9	.12	.029	.073
	Offsite	24	6.9	1.3	3.4	.12	.026	.082
December	Onsite	32	4.1	.8	2.5	.10	.030	.062
	Offsite	23	3.9	.4	2.3	.098	.019	.062
Annual summary	Onsite	382	9.0	0.6	3.2±0.1	1.2	0.029	0.30±0.02
	Offsite	288	7.0	0.4	3.1±0.1	0.98	0.019	0.31±0.03

[a] These results were obtained by measuring the samples 4 days after they were collected in order to avoid counting the natural radioactivity due to radon and thoron decay products.

Table 2. Gamma-ray radioactivity in air-filter samples, Argonne National Laboratory, January–December 1971

Radionuclide	Location	Concentration [a] (fCi/m³)												Annual average
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Antimony-125	Onsite	<1	1	3	4	8	6	6	4	2	1	1	1	3
	Offsite	<1	1	3	5	7	7	7	4	2	1	1	1	3
Barium-lanthanum-140	Onsite	<1	<1	3	<1	<1	<1	<1	<1	<1	1	1	1	<1
	Offsite	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	1	<1
Beryllium-7	Onsite	71	78	88	120	130	120	120	110	110	85	86	65	97
	Offsite	68	76	94	120	120	110	130	120	100	86	92	70	100
Cerium-141	Onsite	<1	2	4	9	10	6	4	2	1	<1	<1	1	4
	Offsite	<1	2	4	9	9	5	5	2	1	<1	<1	1	5
Cerium-144	Onsite	14	18	32	79	130	140	130	78	28	17	10	8	58
	Offsite	14	17	33	77	120	130	140	73	26	17	13	8	56
Cesium-137	Onsite	2	2	3	6	10	10	10	5	2	2	1	1	4
	Offsite	2	2	3	6	9	9	10	5	2	2	1	1	4
Cobalt-60	Onsite	<1	<1	5	10	1	<1	1	<1	<1	<1	<1	<1	<2
	Offsite	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iodine-131	Onsite	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10
	Offsite	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10	10	<10
Manganese-54	Onsite	<1	<1	<1	<1	1	1	1	1	<1	<1	<1	<1	<1
	Offsite	<1	<1	<1	<1	1	1	1	1	<1	<1	<1	<1	<1
Ruthenium-103	Onsite	3	5	12	29	33	25	19	6	2	1	<1	1	12
	Offsite	3	5	12	29	32	22	18	7	2	1	<1	1	11
Ruthenium-rhodium-106	Onsite	16	18	25	53	88	95	92	55	32	19	16	13	44
	Offsite	17	20	32	56	81	85	95	55	27	19	16	12	43
Zirconium-niobium-95	Onsite	9	24	68	200	300	290	250	110	28	13	7	4	110
	Offsite	9	26	68	200	290	260	270	110	29	14	9	4	110

[a] For averaging purposes individual sample results that were less than the minimum detectable concentration were assumed to be one half of the minimum detectable concentration.

made with a spectrometer that used a shielded 35 cm³ lithium-drifted germanium diode as the detector. The detector was calibrated for each nuclide given in table 2.

The activities were either very similar on and off the site, or, for two nuclides, slightly higher on the site. This indicates that most of the airborne particulate activity originated from widespread sources, such as fallout from nuclear test detonations or naturally-occurring materials, and not from localized sources, such as the laboratory. Small amounts of barium-lanthanum-140 and cobalt-60 (up to a maximum of 0.002 percent and 0.07 percent, respectively, of the AEC standards for uncontrolled areas) were detected in some of the samples collection during March, April, May, and July at one location on the laboratory site (10H in figure 1), and were the result of Argonne operations in that area. These two nuclides were not detected off the site at those times; their detection limits are less than 0.0001 percent of the AEC standards.

The alpha radioactivities were normal and in the range found previously. As in the past, most of the beta and gamma radioactivity was due to fission and neutron activation products from nuclear test detonations, although about one-third of the gamma activity and a smaller fraction of the beta radioactivity was due to beryllium-7, which is produced in the stratosphere by cosmic-ray interactions. The total beta radioactivity and most gamma-ray emitters, including the naturally-occurring beryllium-7, increased steadily from January to May, then generally decreased during the remainder of the year. This variation can be attributed to the usual "spring maximum" in the stratospheric fallout rate. The fact that the concentrations of the longer-lived fission products varied in approximately the same manner as beryllium-7 (except that they decreased at a greater rate during the latter part of the year through radioactive decay, since, unlike beryllium-7, they are not produced continuously) is evidence that the bulk of the fission products was also derived from the stratosphere.

The presence of very low amounts of the short-lived fission products, iodine-131 and barium-140 [this nuclide was detected qualitatively, but the concentration (less than 1 fCi/m³) was too low to quantitate] early in January and the sharp increase in 40-day ruthenium-103 and 65-day zirconium-95 in the spring, imply a nuclear test detonation late in 1970 in which some of the fission products were injected into the atmosphere at high altitudes.

The detection of short-lived fission products, iodine-131 and barium-140, at all sampling locations again during the last quarter of the year indicates the presence of fallout from tests that occurred within a few weeks of their detection. These variations in the concentrations of the fission products can be correlated with announced nuclear tests. The average beta radioactivity for the year, 0.3 pCi/m³, was about 15 percent higher than in 1970, and this difference is accounted for principally by the increased concentrations of intermediate half-life fission products, notably zirconium-niobium-95 and cerium-144, during the second quarter of 1971.

Precipitation collected on the site contained the same fission products found in the air samples. Composite monthly precipitation samples collected through May were also analyzed for iron-55 by radiochemical separation and liquid scintillation counting. Concentrations, expressed in terms of ground deposition, ranged from <2.3 to 15 pCi/m², about 20 times less than 1970. Iron-55 was produced principally in nuclear tests conducted in September and October 1961, and the above concentrations have been corrected for decay to October 15, 1961, for comparison purposes. Since iron-55 decays by electron capture and does not emit any gamma-rays, this nuclide does not contribute to the beta and gamma radioactivities given in tables 1 and 2.

Air was sampled continuously for radioiodine with activated charcoal in the 200 and 300 areas because of the possibility of iodine releases in these areas. Very small amounts of iodine-131 were detected early in January and were probably produced in nuclear tests conducted late in 1970, along with the other short-lived fission products found in the air-filter samples. No iodine activity was detected at any other time during the year at either location.

Air sampling for argon-41, a beta emitter with a 1.8 hour half-life that is produced in an operating reactor by neutron irradiation of the stable argon in air, was conducted near the CP-5 reactor (building 330). Samples were collected once a day from 2 to 5 times during each week of reactor operation. Each sampling consisted of two "grab" samples, one taken 50 yards east of the reactor and one downwind from the reactor at a point favorable for detection of argon-41. No samples were collected during August, December, and the second half of July when the reactor was not operating. The results are given in table 3. Because of the timing and location of the sampling collection, the actual average concentration in the vicinity of the reactor was less than the values in the table. The average and maximum concentrations of 86 and 1,200 nCi/m³ are, respectively, about 2.2 and 29 times the AEC standard for uncontrolled areas and 0.044 and 0.6 times the standard for controlled areas (2 μCi/m³). In this case, comparison with the AEC standard for controlled areas is more appropriate since the sampling is conducted on the site. At the site security fence, the closest uncontrolled approach to the laboratory, the concentrations were less than the detection limit (20 nCi/m³).

Table 3. Argon-41 concentrations near CP-5 reactor, January–December 1971

Month	Number of samples	Concentration * (nCi/m³)		Percent of AEC standard	
		Maximum	Average	Maximum	Average
January	36	300	35	750	88
February	32	218	42	545	105
March	38	400	73	1,000	182
April	34	495	49	1,240	122
May	32	1,110	69	2,780	172
June	16	428	37	1,070	92
July	4	453	152	1,130	380
August	0				
September	12	620	140	1,550	350
October	14	880	155	2,200	388
November	16	1,150	107	2,880	268
December	0				
Annual summary	234	1,150	86±6	2,880	215

* Minimum detectable concentration—20 nCi/m³.

Table 4. Tritium concentrations in air, Argonne National Laboratory, January–December 1971

Date (1971)	300 Area					East area				Offsite			
	Number of samples	Concentration (pCi/m³)			Percent of AEC standard [a]		Number of samples	Concentration (pCi/m³)			Number of samples	Concentration (pCi/m³)		
		Maximum	Minimum	Average	Maximum	Average		Maximum	Minimum	Average		Maximum	Minimum	Average
January	26	1,130	1.4	213	0.56	0.11	2	2.3	0.55	1.4	2	0.37	0.23	0.30
February	24	1,160	1.8	267	.58	.13	2	5.8	4.3	5.1	3	4.1	1.0	2.2
March	26	1,570	5.7	355	.78	.18	4	5.3	1.3	3.0	4	2.4	1.0	1.6
April	26	1,630	5.9	331	.82	.17	1	2.2			1	2.0		
May	26	2,150	5.2	234	1.07	.12	2	22	4.2	13	2	7.2	3.6	5.4
June	12	4,080	20.8	847	2.04	.42	1	7.2			1	9.2		
July	10	1,190	60.2	646	.60	.32	1	14			1	12		
August	8	396	20.6	121	.20	.06	1	11			1	7.2		
September	10	1,500	92	370	.75	.18	1	6.1			1	5.4		
October	8	531	116	346	.26	.17	1	1.8			1	2.9		
November	7	1,500	176	594	.75	.30	1	8.6			1	15		
December	10	474	65.1	250	.24	.12	1	13			1	1.4		
Annual summary	193	4,080	1.4	381±21	2.04	0.19	18	22	0.55	7.2±2.2	19	15	0.23	5.4±2.1

[a]AEC standard for uncontrolled areas.

Tritiated water vapor was monitored in air on and off the site because substantial amounts are in use at the laboratory. Tritium is produced continuously in an operating reactor by several methods. In CP–5 the largest source is by neutron irradiation of the heavy water used for cooling and neutron moderating. Air was sampled for tritiated water vapor at a permanent station 50 yards east of the CP–5 reactor and simultaneously 200 yards downwind of the reactor. The water vapor was removed from the air by absorption on silica gel, and the tritium was measured by counting the water in a liquid scintillation counter. Collection was continuous for the first 6 months of the year and from Monday to Friday during the second half. The results, given in table 4 were all positive, although the concentrations were well below the AEC standards. As in the case of argon-41 near the reactor, application of the standards for controlled areas is appropriate. Since this standard, 5 μCi/m³ is 25 times larger than that for uncontrolled areas, the percent of standard given in table 4 is reduced by this factor for this comparison.

As will be seen, normal or background tritium concentrations in air during 1971 ranged from about 0.2 to 15 pCi/m³ and averaged about 5 pCi/m³. Near CP–5 the average was 380 pCi/m³, and the difference was due to tritium that left the reactor building. The average concentration near the reactor was about 35 percent higher than in 1970, principally as the result of a small leak in the CP–5 heat exchanger which allowed some of the heavy water to enter the secondary cooling water system and thus escape to the atmosphere. This leak has since been corrected.

Since tritium is produced in nuclear tests and continuously in the upper atmosphere by cosmic-ray interactions with air, tritiated water vapor is present in small concentrations at all locations. To determine the distance from CP–5 that tritium, originating in the reactor, could be detected and distinguished from background tritium, measurements were also made at various distances from the site. Table 5 shows the results of simultaneous collections at CP–5 and in four directions from the reactor. The tritiated water concentration in air is variable, and depends in part on the humidity. During the period of these sample collections, concentrations up to 10–15 pCi/m³ were normal. The results in table 5 show good correlation with wind direction and indicate that dilution to background levels occurs within 650 yards of the reactors in directions other than that from which the wind is blowing. The site security fence is reached at this distance from the reactor in the southwest corner of the laboratory. At this location, the average and maximum concentrations of the four samples in table 5 were equivalent to 0.02 and 0.09 percent of the AEC standards, respectively.

Table 5. Tritium concentrations in onsite air samples Argonne National Laboratory, 1971

Location	Concentration (pCi/m³)			
	May 7	May 14	May 21	July 18
CP–5	398	240	89	325
650 yards north	14	20	178	23
650 yards west	44	87	6.9	13
650 yards south	22	14	4.5	146
650 yards east	7.8	14	5.6	56
Wind direction [a]	45°–120° (NE-SE)	60°–135° (NE-SE)	190° (S)	270°–300° (W-NW)

[a] Direction from which wind was blowing.

Samples were also collected from 1 to 4 times per month at an onsite location in the East Area 2,000 yards northeast of the reactor and offsite at a location approximately 6 miles northwest of the laboratory. A comparison of the results (table 4) indicate no significant differences between the average concentrations at these two locations. The offsite concentrations may be considered normal for this area; the average and maximum concentrations (5.4 and 15 pCi/m³, respectively) are very similar to those found in 1970 (5.6 and 13 pCi/m³). While the East Area samples did not usually show the effect of CP–5, occasionally, when the wind was from the southwest and the tritium concentration near the reactor was sufficiently high, the concentration reached twice the normal background level. For example, on May 4, when the concentration near CP–5 was 270 pCi/m³, the East Area sample contained 22 pCi/m³ and the wind was from the southwest (i.e., from the direction of CP–5), while the offsite sample concentration was 7.2 pCi/m³. This difference can be attributed to CP–5, and during 1970 this correlation between prevailing wind direction and the concentrations at CP–5 and the East Area occurred a number of times. On this basis, concentrations in the range of 15 to 30 pCi/m³ (0.008 to 0.015 percent of the standards) can be attributed to CP–5 at a distance of 2,000 yards from the reactor in the direction of the wind. This distance is past the site security fence to the west and south of the laboratory, but is within the boundary of the ANL site.

Radioactivity in surface water

Argonne wastewater is discharged into Sawmill Creek, a small stream that runs through the laboratory grounds, drains surface water from much of the site, and flows into the Des Plaines River about 500 yards downstream from the wastewater outfall. Sawmill Creek was sampled upstream from the Argonne site and downstream from the wastewater outfall to determine if radioactivity was added to the stream in Argonne wastewater or from surface drainage. The sampling locations are shown in figure 2. Below the wastewater outfall, the creek was sampled continuously, and the individual samples collected five times weekly. Since it was impractical to analyze all the samples for all the nuclides and elements desired, equal portions of the samples collected each week were combined and analyzed. The results obtained in this way represent the average concentrations in the weekly samples. Above the site, samples were collected bimonthly, and selected samples were analyzed for the same radionuclides as the below outfall samples.

The total (nonvolatile) alpha and beta activities were determined by counting the residue remaining after evaporation of the water, and applying counting efficiency corrections determined for uranium-233 (for alpha activity) and thallium-204 (for beta activity), respectively, to obtain disintegration rates. Tritium was determined by liquid scintillation counting of a separate sample, and this activity does not appear in the total beta activity. Uranium was determined fluorophotometrically, and the results calculated in terms of activity assuming the isotopic composition of natural uranium. Analyses for other radionuclides were performed by specific radiochemical separations followed by appropriate counting. One liter aliquots were used for all analyses except tritium and plutonium (during the second half of the year). Tritium was analyzed by counting 10 ml in a gel system. Beginning in July, plutonium analyses were performed on 10-liter samples by chemical separation followed by alpha spectrometry. Plutonium-236 was used to determine the yield.

Annual summaries of the results obtained for Sawmill Creek are given in table 6. Comparison

Table 6. Radioactivity in Sawmill Creek water, Argonne National Laboratory, January–December 1971

Type of activity	Location	Number of samples	Concentration (pCi/liter)			Percent of AEC standard		
			Maximum	Minimum	Average	Maximum	Minimum	Average
Alpha (nonvolatile)	Upstream	24	4.2	0.6	2.0±0.3			
	Downstream	254	2.7	.5	1.3±.2			
Beta (nonvolatile)	Upstream	24	39	9	24±3			
	Downstream	254	29	11	19±2			
Plutonium [a] (alpha)	Upstream	6	<.05	<.05	<.05	<0.001	<0.001	<0.001
		3	<.05	<.05	<.05	<.00004	<.00004	<.00004
	Downstream	60	.16	<.05	<.05	.003	<.001	<.001
		60	.0086	<.002	.0038±.0008	.0002	<.00004	.00008
Tritium	Upstream	12	500	<200	360±65	.017	<.0067	.012
	Downstream	253	220,000	300	11,300±3,300	7.3	.010	.38
Uranium (alpha)	Upstream	6	2.0	.66	1.4±.4	.005	.002	.004
	Downstream	60	2.2	.96	1.6±.2	.005	.002	.004
Thorium (alpha)	Upstream	6	<.05	<.05	<.05	<.003	.003	.003
	Downstream	60	<.05	<.05	<.05	<.003	.003	.003
Barium–140	Upstream	5	<2	<.02	<.02	<.007	.007	.007
	Downstream	50	<2	<.02	<.02	<.007	.007	.007
Cesium–137	Upstream	3	<.5			<.003	<.003	<.003
	Downstream	45	2.0	<.5	<.5	.010	<.003	<.03
Iodine–131	Upstream	–	–	–	–			
	Downstream	109	<3	–	–	<1	<1	<1
Strontium–89	Upstream	5	<2	<2	<2	<.07	<.07	<.07
	Downstream	50	<2	<2	<2	<.07	<.07	<.07
Strontium–90	Upstream	5	2.3	.66	1.4±.7	.8	.02	.5
	Downstream	50	2.5	.60	1.6±.4	.8	.02	.5
Technetium–99	Upstream	3	<.5	<.5	<.5	<.0002	<.0002	<.0002
	Downstream	45	.84	<.5	<.5	.0003	<.0002	<.0002

[a] Two sets of data are given for plutonium because of the introduction in July of a new analytical procedure which improved the sensitivity by a factor of 25. The first set of values for each location covers the first half of the year.

of the results, and 95-percent confidence limits of the averages, for the two sampling locations show that the only nuclides whose presence in the creek water can be attributed to Argonne operations were tritium, plutonium-239, technetium-99, and cesium-137. Approximately 90 percent of the individual samples contained tritium attributable to Argonne, while the other nuclides were found in less than 10 percent of the samples. The concentrations of all four nuclides were quite low compared to the AEC standards. The principal radionuclide added to the creek by Argonne wastewater, in terms of both concentration and percent of the AEC standards, was tritium. The average Argonne contribution of this nuclide to the creek amounted to only 0.4 percent of the standards and the highest concentration in any single sample was equivalent to 7.3 percent of the standards. The principal source of the tritium in Argonne wastewater was the heavy water from the CP–5 reactor that entered the water treatment system because of the heat-exchanger leak discussed in the section on air activity. This was an unusual situation that has since been corrected. The tritium in the creek above the site was produced principally in nuclear tests.

The total alpha and beta radioactivities were higher, on the average, above the site, indicating that at times Argonne wastewater contained less nonvolatile activity than creek water. The high activities above the site are probably due to the water added to the creek by a large (one million gallons per day) municipal sewage treatment plant. The large amount of dissolved solids added in the sewage water is accompanied by a small amount of radioactive nuclides, and tends to increase the concentration in natural creek water. The alpha radioactivities were about one-third lower than in 1970 because the 1971 samples were acidified and filtered prior to analysis to remove suspended solids. These solids, particularly soil, contain considerably more natural activity than the water with which they are associated. This difference is not noticeable in the total beta radioactivity because the water contains appreciable soluble beta activity from natural potassium-40 and from fallout.

In addition to the natural beta radioactivity and that added by wastewater below the outfall, beta radioactivity from nuclear detonations was detected at both sampling locations. The normal nonvolatile beta activity is approximately 5 to 8 pCi/liter above the site and 3 to

8 pCi/liter below the site, depending on the amount of dilution by wastewater. It is estimated that fallout activity added about 10 to 15 pCi/liter to the nonvolatile beta radioactivity at both locations (fallout is added to the water below the outfall directly from the air as well as by above-site water) and the Argonne contribution below the outfall averaged 1 pCi/liter. The Argonne contribution remained the same as 1970 levels, while the fallout contribution increased by 30 percent.

The same nuclides added to the creek in Argonne wastewater are also produced in nuclear detonations and are constituents of fallout (although some are not present in amounts above the detection limits). The total concentration, regardless of source, must be used in assessing the health hazard of a radionuclide not naturally present, and the percent of the AEC standards for all nuclides listed in table 6 were very low.

Since Sawmill Creek empties into the Des Plaines River, which in turns flows into the Illinois River, the radioactivity in the latter two streams is important in assessing the contribution of Argonne wastewater to the environmental radioactivity. The Des Plaines River was usually sampled twice a month below and bimonthly above the mouth of Sawmill Creek to determine if the radioactivity in the creek had any effect on the activity in the river. Annual summaries of the radioactivity concentrations at these two locations are given in table 7. Additional samples were collected from the river below Sawmill Creek and analyzed for tritium during August, when secondary CP–5 cooling water into which some of the primary cooling water had leaked, was processed. Except for tritium, the concentrations were in their normal ranges. The natural nonvolatile beta radioactivity in the river is about 5 pCi/liter, and the excess, about 8 pCi/liter was due to fallout. The alpha radioactivity averaged about one-third less than in 1970 for the same reason given in the discussion on Sawmill Creek water; namely, the samples were filtered to remove suspended solids.

The effect of Sawmill Creek water on the tritium concentration at location B is apparent from the table. The average concentration was about twice its normal value, but the percent of AEC standard (0.03 percent) was small. For comparison purposes, the tritium concentration at location B in 1970 averaged about one-third less, 620 pCi/liter. Tritium was the only nuclide found in the Des Plaines River that could be attributed to Argonne wastewater or to Sawmill Creek. Any other activity in Sawmill Creek was diluted to undetectable levels in the river. A comparison of the tritium concentrations in Sawmill Creek and the Des Plaines River taken at appropriate times dur-

Table 7. Radioactivity in Des Plaines River water, Argonne National Laboratory, January–December 1971

Type of activity	Location	Number of samples	Concentration (pCi/liter)			Percent of AEC standard		
			Maximum	Minimum	Average	Maximum	Minimum	Average
Alpha	Upstream	5	3.1	1.1	1.9±0.7			
(nonvolatile)	Downstream	21	2.0	.6	1.6±.2			
Beta	Upstream	5	18	6.6	12 ± 4			
(nonvolatile)	Downstream	21	21	6.5	14 ± 2			
Plutonium	Upstream	3	<.05	<.05	<.05	<0.001	<0.001	<0.001
(alpha)	Downstream	5	<.05	<.05	<.05	<.001	<.001	<.001
Tritium	Upstream	3	580	390	500 ±150	.019	0.013	0.017
	Downstream	41	12,000	<200	980 ±190	.43	<.0067	.033
Uranium	Upstream	2	1.8	1.8	1.8±.1	.005	.005	.005
(alpha)	Downstream	5	2.5	1.6	1.9±.4	.006	.004	.005
Thorium	Upstream	3	<.05	<.05	<.05	<.003	<.003	<.003
(alpha)	Downstream	5	<.05	<.05	<.05	<.003	<.003	<.003
Barium–140	Upstream	3	<2	<2	<2	<.007	<.007	<.007
	Downstream	5	<2	<2	<2	<.007	<.007	<.007
Cesium–137	Upstream	NS	NS	NS	NS			
	Downstream	2	<.5	<.5	<.5	<.003	<.003	<.003
Strontium–89	Upstream	3	<2	<2	<2	<.07	<.07	<.07
	Downstream	5	<2	<2	<2	<.07	<.07	<.07
Strontium–90	Upstream	3	2.5	1.6	2.0±.8	.8	.5	.7
	Downstream	5	2.2	1.3	1.7±.4	.7	.4	.6

ing August showed that when the concentration in Sawmill Creek water was about 70 nCi/liter, the average and maximum concentrations in the Des Plaines River, after subtracting the normal concentration, were about 2 and 12 nCi/liter, respectively. This indicates an unexpectedly low dilution factor, about 25, and may be due to incomplete mixing, a below-average water level in the river during August, and the recent substantial increase in the volume of Sawmill Creek water due to the municipal sewage treatment plant. Previous studies gave a dilution factor of about 10^3. The activities in samples of Illinois River water (table 8) were similar to those found in other bodies of water in the area and to the activities found previously at these same locations, and no radioactivity originating at Argonne could be detected.

Table 8. Average radioactivity in Illinois River water Argonne National Laboratory, 1971

Location	Concentration (pCi/liter)			
	Alpha radioactivity	Uranium	Beta radioactivity	Tritium
McKinley Woods State Park *	0.89	0.52	7.4	270
Morris *	.89	.86	7.7	330
Starved Rock State Park *	1.1	.74	8.1	260

* Collected October 7, 1971.

Plutonium in soil and grass

Plutonium deposition in soil and grass was measured on and off the site to study the plutonium fallout level in the area from nuclear testing and to determine if any plutonium is present in the environment that might be due to Argonne operations.

Samples were ignited at 600° C. to remove organic matter and prepared for plutonium analysis by treatment with hot hydrochloric, hydrofluoric, and nitric acids. This treatment has been found to solubilize plutonium in soil that has been ignited at 1,000° C. The plutonium was separated from nitric acid solution on an anion-exchange column, electrodeposited, and its composition determined by alpha spectrometry. Alpha spectrometry cannot distinguish between plutonium-239 and plutonium-240, although in the following discussion and in the tables, only plutonium-239 is mentioned. It should be understood that the alpha activity due to the less abundant plutonium-240 isotope is also included. The chemical recovery was determined by adding a known amount of plutonium-236 tracer to the sample before analysis. Soil samples were collected from a known area and depth; the grass samples were obtained by collecting all the grass from a known area.

The results are given in tables 9 and 10. The limits given for the individual results are the statistical counting errors at the 95-percent confidence level, while the limits of the averages are the 95-percent confidence levels of the standard deviation of the average. The analyses of the July and August samples were performed on 20 to 50 gram aliquots of the samples. Although this sample size is sufficient to obtain good accuracy for the plutonium-239 content, the plutonium-238 concentrations were so low that the statistical counting errors were of the order of 100 percent, although positive results were obtained in all cases. The problem was aggravated by the presence of a small amount of plutonium-238 in the plutonium-236 tracer. One hundred-gram portions of the November samples were analyzed, and with this sample size the plutonium-238 counting error was reduced to about 30 percent.

In comparing results from different locations, it is essential to know the sampling depth. Two sampling depths were used for the collections, 0 to 5 cm and 0 to 30 cm. Two samples were subdivided to measure concentration as a function of depth. These results, as well as the averages in table 9 for the two sampling depths, show that one-half to two-thirds of the plutonium down to 30 cm is in the first 5 to 10 cm.

Comparison of the onsite and offsite samples collected from 0 to 5 cm show that the same range and average concentrations exist in all areas for both plutonium isotopes, and it may be concluded that the plutonium in all of these samples resulted from fallout of debris from nuclear detonations. Among the onsite samples

Table 9. Plutonium concentrations in onsite soil, Argonne National Laboratory, 1971

Date collected (1971)	Location [a]	Depth (cm)	Plutonium-239		Plutonium-238		$^{238}Pu/^{239}Pu$ [b]
			(fCi/g)	(nCi/m²)	(fCi/g)	(nCi/m²)	
6–17	10P	0–5	21 ±2	1.0 ±0.1	0.9±0.9	0.04±0.04	0.04
6–17	8N	0–5	16±2	.75± .11	.8± .8	.04± .04	.05
6–17	12C	0–5	25±2	1.3 ± .1	1.2±1.1	.06± .06	.05
6–18	14L	0–5	24±2	1.2 ± .1	1.1±1.1	.05± .05	.04
6–18	14N	0–5	30±2	1.4 ± .1	.9± .9	.04± .04	.03
6–18	14E	0–5	19±2	.85± .06	1.0±1.0	.05± .05	.06
6–18	7E	0–5	26±2	1. 1± .1	1.0±1.0	.04± .04	.04
6–18	4G	0–5	10±2	.42± .06	.6± .6	.02± .02	.05
8–24	13N	0–5	29±2	1.8 ± .1	2.0±2.0	.1 ± .1	.06
8–24	14I	0–5	19±2	.93± .07	1.0±1.0	.05± .05	.05
8–24	17H	0–5	16±2	1.1 ± .2	1.7±1.7	.13± .10	.12
8–24	10E	0–5	18±2	1.0 ± .2	1.3±1.3	.08± .08	.08
8–24	13D	0–5	24±2	1.9 ± .1	1.0±1.0	.08± .08	.04
8–24	6J	0–5	16±2	1.0 ± .2	.6± .6	.03± .03	.03
8–24	8L	0–5	24±2	1.5 ± .1	2.1±1.6	.1 ± .1	.07
8–24	5H	0–5	17±2	1.1 ± .2	.7± .7	.04± .04	.04
8–24	5D	0–5	18±2	1.1 ± .1	1.2±1.2	.07± .07	.06
8–24	10M	0–5	14±2	.93± .14	.9± .9	.06± .06	.06
8–24	9N	0–5	24±2	1.5 ± .1	1.2±1.2	.07± .07	.05
8–24	10N	0–5	9.4±1.0	.70± .11	.8± .8	.06± .06	.09
8–24	15O	0–5	27±2	1.3 ± .1	.9± .9	.04± .04	.03
8–24	16J	0–5	20±2	1.0 ± .1	1.1±1.0	.06± .05	.06
8–25	11C	0–5	22±2	1.2 ± .1	1.0± .7	.05± .04	.04
8–25	15F	0–5	21±2	.92± .09	.8± .8	.40± .04	.04
8–25	15F	5–10	14±2	.61± .09	.6± .6	.03± .03	.05
8–25	15F	10–15	1.4±.8	.11± .04	.2± .2	.01± .01	.09
Average				1.2 ±0.14		0.06±0.01	
11–11	12M	0–30	24±1	4.1 ± .2	.8± .2	.14± .05	.03
11–11	12M	0–30	12± 1	1.9 ± .2	.9± .3	.13± .04	.07
11–11	12M	0–30	21±1	2.9 ± .2	.8± .3	.10± .04	.03
11–11	12M	0–30	13± .1	2.1 ± .2	.8± .3	.12± .04	.06
11–11	11G	0–30	9.2±1	1.1 ± .1	.6± .2	.07± .02	.06
11–11	11G	0–30	18±1	2.1 ± .1	1.0± .3	.11± .03	.05
11–11	10H	0–30	15±1	2.0 ± .1	.9± .3	.12± .04	.06
11–11	10H	0–30	13±1	2.4 ± .2	.7± .2	.12± .03	.05
11–11	8H	0–30	14±1	2.2 ± .2	.6± .2	.09± .03	.04
11–11	8I	0–30	14±1	2.2 ± .2	.9± .3	.14± .05	.06
11–11	9I	0–7.5	18±1	1.7 ± .1	.8± .2	.08± .02	.04
11–11	9I	7.5–15	4.5± .4	.42± .04	.7± .2	.06± .02	.14
11–11	9I	15 –22.5	2.5± .3	.28± .03	.1± .5	.02± .1	.04
11–11[c]	9I	22.5–30	2.7± .3	.25± .03	.7± .2	.06± .02	.24
11–11	9H	0 –30	13 ± 1	1.9 ± .1	.7± .2	.11± .03	.06
Average				2.3± .4		.12± .02	

[a] The locations are given in terms of the grid coordinates in figure 1.
[b] As calculated from concentrations in nCi/m².
[c] For average purposes, these results form a single sample.

Table 10. Plutonium concentrations in offsite soil, Argonne National Laboratory, 1971

Date collected (1971)	Location [a]	Plutonium-239		Plutonium-238		$^{238}Pu/^{239}Pu$
		(fCi/g)	(nCi/m²)	(fCi/g)	(nCi/m²)	
9–28	German Church & Wolf Roads, Willow Springs	7.4±0.2	0.25±0.05	0.75±0.64	0.025±0.021	0.10
9–28	McCormick Woods, Brookfield	30±2	1.5± .1	1.8± .9	.093± .047	.06
10–5	Magician Lake Park, Mich	74±4	.66± .03	4.2±1.9	.038± .017	.06
10–7	Starved Rock State Park	16±2	1.0± .2	.9± .9	.06 ± .06	.06
10–7	McKinley Woods State Park	22±2	1.1± .1	1.2±1.1	.057± .052	.05
10–12	Delavan, Wisc	40±2	2.3± .1	1.9±1.3	.11 ± .08	.05
10–12	Pioneer Park, Naperville	24±2	2.1± .2	1.9±1.3	.17 ± .10	.08
10–14	Park Forest	38±2	1.6± .1	1.8±1.2	.076± .050	.05
10–14	Monticello, Ind	8.9± .2	.48± .10	1.0±1.0	.05 ± .05	.11
Average			1.2±0.5		.08 ±0.03	

[a] Sampling depth is 0–5 cm.

Table 11. Plutonium content of soil, 1969–1971

Reporting laboratory	Sample location	Date	Depth (cm)	Concentration (nCi/m²)		Reference
				Plutonium-239	Plutonium-238	
New York AEC Health & Safety Laboratory:	Argonne Park: (12–0, figure 1)	1970	0–30	2.1	0.07	(4)
	New York City (5 samples)	1970	0–20 0–30 0–60	2.0—2.6		(2,3)
	West, Midwest U.S. (4 samples)	1970	0–20	1.8—2.4		(3)
	New York City	1969	0–5	1.6	.07	(3)
	New York City	1969	5–20	.4	.03	(3)
Lawrence Radiation Laboratory:	Livermore, Calif. (7 samples)	1971	0–20	.6—2.6	.02— .29	(5)

collected to a depth of 30 cm, one sample, containing 4.1 nCi/m² of plutonium-239, is outside the range expected from fallout. The plutonium concentrations in the remainder of the 0-30 cm group are normal for this area. This group of samples was collected near buildings in which plutonium has been used, so the possibility of plutonium in their vicinity exists. The area in which the above-normal sample was collected is being analyzed in detail to determine if plutonium contamination does, in fact, exist since the single value obtained thus far is not sufficiently high to allow an unequivocal conclusion.

Except for the one sample mentioned above, the deposition concentrations found on and near the site are similar to those reported by other laboratories, and attributed by them to fallout. These are summarized in table 11. The plutonium-239 content of grass (table 12) was similar on and off the site, and in terms of deposition, about one to two thousand times less than in soil from the same location.

Table 12. Plutonium-239 concentrations in grass Argonne National Laboratory, 1971

Date collected (1971)	Location	Concentration	
		(fCi/g dry weight)	(pCi/m²)
Onsite:			
6/17	8N	3.7±1.7	0.53±0.24
6/17	12C	1.9± .9	.12± .06
8/24	13N	5.2±1.4	1.1 ± .3
8/24	8L	4.3±1.8	.78± .33
8/24	10M	2.3±1.1	.50± .24
Offsite:			
9/28	German Church & Wolf Roads, Willow Springs	2.2±1.1	.77± .39
10/7	McKinley Woods State Park	5.5±3.4	2.1 ±1.3

Radioactivity in milk

Raw milk was collected monthly from a local dairy farm and analyzed for several fission products. Barium-140, strontium-89, and iodine-131 were not present in concentrations greater than the minimum detectable amounts of 20 pCi/liter for iodine-131 and 2 pCi/liter for the other two nuclides. The cesium-137 and strontium-90 concentrations are given in table 13. These two nuclides are long-lived fission products from past nuclear tests and their presence in milk is not related to Argonne operations. The average strontium-90 content decreased by 20 percent from last year, while the cesium-137 concentrations were nearly unchanged.

The concentrations given in table 13 may be compared to the AEC standards for drinking water. These values are 300 pCi/liter for strontium-90 and 20 nCi/liter for cesium-137 if the daily intake of water is 2.2 liters. The consumption of 1 liter of milk per day would then result in an average intake of 0.85 percent of the strontium-90 and 0.03 percent of the cesium-137 AEC standards. Using the standards specified by the Federal Radiation Council, 1 liter of milk is equivalent to 0.85 and 2.8 percent of the daily intake guides for cesium-137 and strontium-90, respectively.

Table 13. Cesium-137 and strontium-90 concentrations in milk, Argonne National Laboratory, 1971

Date collected (1971)	Concentration (pCi/liter)	
	Cesium-137	Strontium-90
January 6	<10 *	6.5
February 3	<10	7.1
March 3	17	5.8
April 7	16	5.8
May 5	40	4.9
June 2	26	4.8
July 7	12	7.0
August 4	12	6.8
September 1	13	6.1
October 6	16	4.1
November 3	<10	4.6
December 1	12	3.2
Average	15	5.6

* <10 = 5 for averaging purposes.

Table 14. Environmental penetrating radiation, Argonne National Laboratory, 1971

Location *	Period of measurement	Days	Dose (mrem/a)
Near site security fence:			
12P	10/12—11/8	27	125
8H	10/12—11/8	27	131
10E	10/12—11/8	27	93
9L	10/22—12/14	53	108
14I	10/22—12/14	53	117
10M	11/5 —12/14	39	106
14L	11/5 —12/14	39	114
14EF	11/5 —12/14	39	96
18J	11/5 — 1/3	59	102
13D	11/5 —12/14	39	74
8F	11/5 —12/14	39	126
12N	11/12—12/13	31	101
9–10L	11/12— 1/3	52	118
10M	11/12— 1/3	52	105
9EF	11/12— 1/3	52	102
14G	11/12— 1/3	52	110
Average			108 ±7
Offsite:			
Woodridge	10/12—11/8	27	93
Downers Grove	11/5 —12/14	39	117
Lemont	11/5 —12/14	39	119
Woodridge	11/5 —12/14	39	96
Lombard	11/12— 1/4	53	115
Route 83	11/12— 1/3	52	85
Average			104 ±12

* Locations shown in figure 1.

Penetrating radiation

Measurements of gamma-ray dose were made beginning October 12 at several locations at or near the site security fence to determine the dose that might be due to Argonne operations at the nearest uncontrolled approach to the laboratory. The dose was measured with thermoluminescent dosimeters (dysprosium-activated calcium fluoride crystals and dysprosium-activated calcium sulfate powder dispersed in Teflon) calibrated against an NBS standard radium-226 source. The results are given in table 14 together with offsite measurements made at the same time. The onsite locations are shown in figure 3 together with the dose.

The averages and their confidence limits show that there was no statistically significant difference between the average dose off the site and at the site fence. However, to determine if any fraction of the site-fence dose is assignable to Argonne, the results must be examined in more detail. Except for the dosimeter at the Route 83 location, which was located on the second floor porch of an apartment building, and thus was partially shielded from both cosmic and terrestial radiation, the offsite dosimeters, which were mounted on trees or posts away from buildings, received doses between 93 and 119 mrem/year. The site-fence readings ranged from 74 to 131 mrem/year. The lowest onsite doses were obtained at the western edge of the site (800 Area), where the ground contains considerable gravel. Since the gravel contains less radium and thorium than clay soil, the terrestial portion of the dose in this area should be lower, and this probably accounts for the lower average readings. Except for the dose of 125 mrem/year in Argonne Park, the highest readings were obtained from the dosimeters located on the south fence line (126 mrem/year at 8F and 131 mrem/year at 8H). The Argonne Park reading appears anomalous since lower and more normal readings were obtained closer to ANL facilities. Neglecting the Argonne Park value pending additional measurements in that area, a reasonable range for the normal dose on the ANL fence and in the ANL environs is between 95 and 120 mrem/year, if one considers the offsite values as normal. Thus, the dose at the south fence that might be attributed to Argonne operations is perhaps 5 to 30 mrem/year. This conclusion must be considered tentative since values of 125 to 130 mrem/year may be natural in some locations. Certainly the dose at the fence line is not greater than the estimate. A better assessment of the dose due to ANL can be made when measurements are available for a longer period of time, perhaps 1 year, and at additional locations.

The annual whole body dose in uncontrolled areas permitted by AEC Manual Chapter 0524 is 500 mrem above natural background, and the dose at any fence line due to laboratory operations is well within this limit. The 500 mrem dose limit may be reduced in the future, probably to some value between 5 and 25 mrem/year, which is of the same order as the maximum dose estimate given above. When and if the change occurs, a better value for the dose due to ANL operations should be available.

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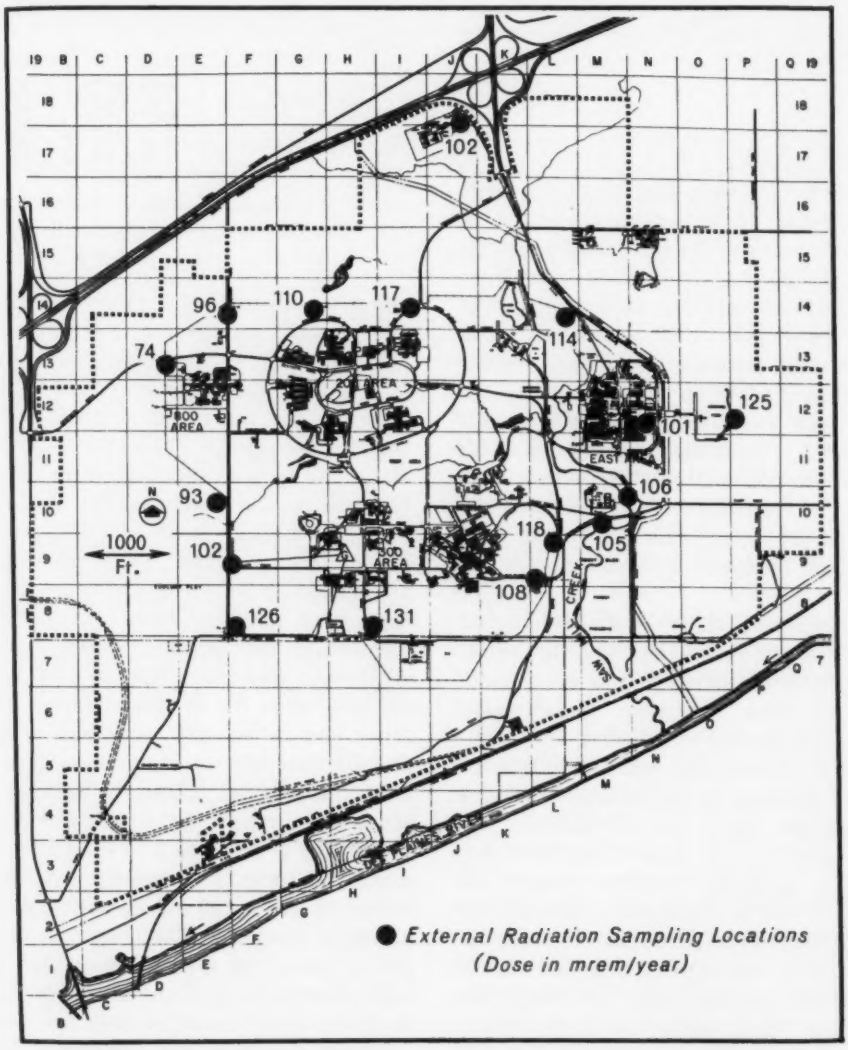

Figure 3. External radiation measurements, Argonne Laboratory

Reported Nuclear Detonations, April 1973

(Includes seismic signals presumably from foreign nuclear detonations)

Seismic signals, presumably from a Soviet underground nuclear explosion were recorded by the United States on April 19, 1973. The signals originated at approximately 11:30 p.m. EST, at the Semipalatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the yield range of 20–200 kilotons.

Announcement was made by the U.S. Atomic Energy Commission of two underground U.S. nuclear tests during April 1973. One was conducted April 25, 1973 and the other, April 26, 1973. Both tests were conducted underground by the Atomic Energy Commission at its Nevada Test Site and were of the low-intermediate yield range of 20 to 200 kilotons TNT equivalent.

Not all of the nuclear detonations in the United States are announced immediately, therefore, the information in this section may not be complete. A complete list of announced U.S. nuclear detonations may be obtained upon request from the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

TRITIUM BURDENS IN TWO ARCTIC VILLAGES. *J. A. Eckert* and *R. B. Evans. Radiation Data and Reports*, Vol. 14, May 1973, pp. 273–275.

During a routine visit to measure cesium-137 burdens in residents of two Alaskan villages, drinking water and urine samples were collected and subsequently analyzed for tritium by the National Environmental Research Center-Las Vegas. The mean concentrations at Noatak, Alaska, were 1,200 pCi/liter and 1,500 pCi/liter for tritium in drinking water and urine, respectively. At Kiana, the mean tritium concentration in drinking water was <400 pCi/liter, and the mean tritium concentration in urine was 1,000 pCi/liter.

KEYWORDS: Alaska, body burden, tritium.

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